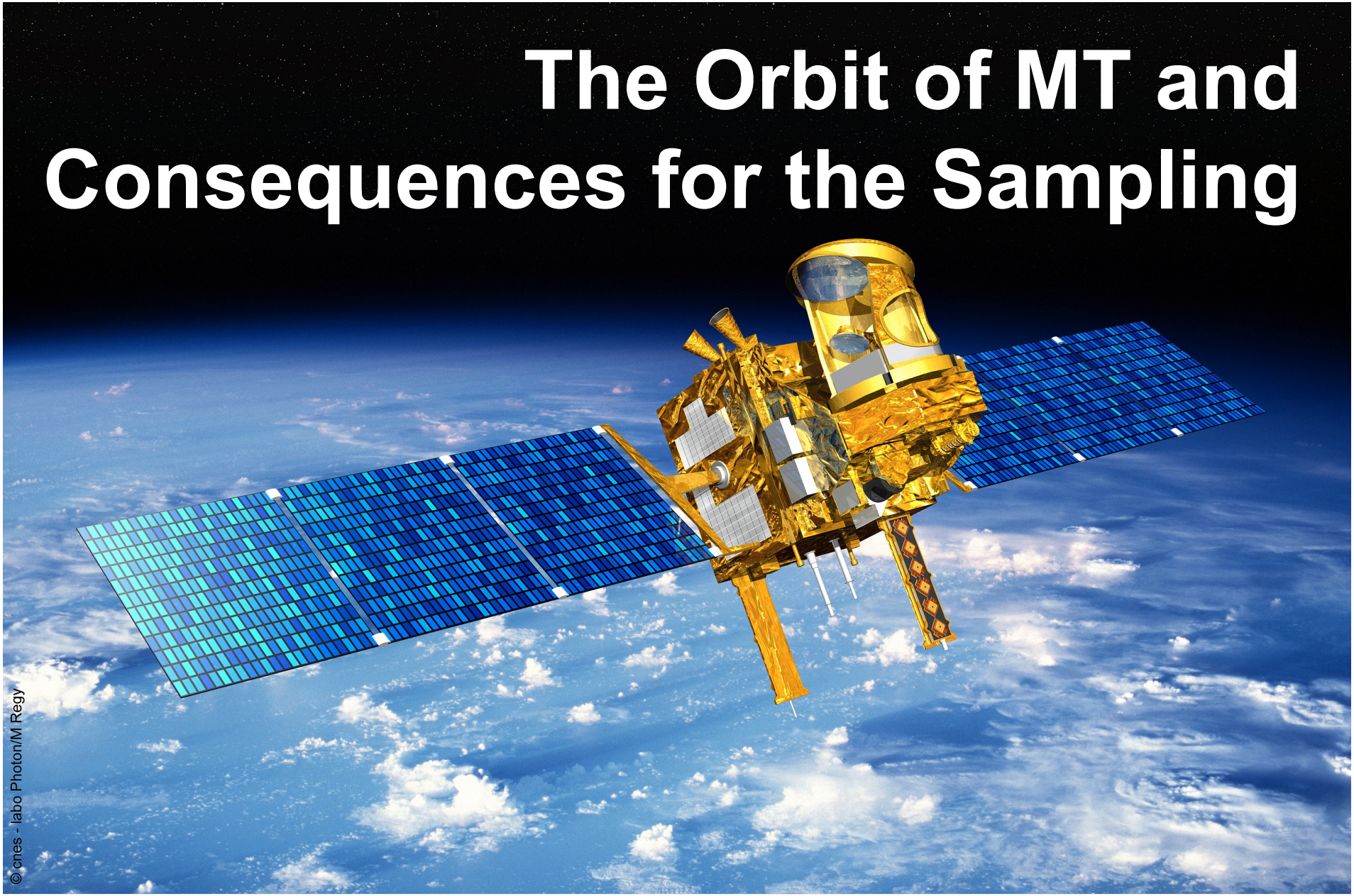
The Orbit of MT and Consequences for the Sampling



Earth Radiation Budget Workshop 2012 - GFDL, Princeton, NJ

Tuesday, October 23

Michel Capderou

LMD / IPSL, Ecole Polytechnique, Palaiseau, France

Megha-Tropiques / ScaRaB
Orbit - ref.: Earth

Altitude = 865.5 km a = 7243.677 km

Inclination = 20.00 °

Recurrence = [14; -1; 7] 97

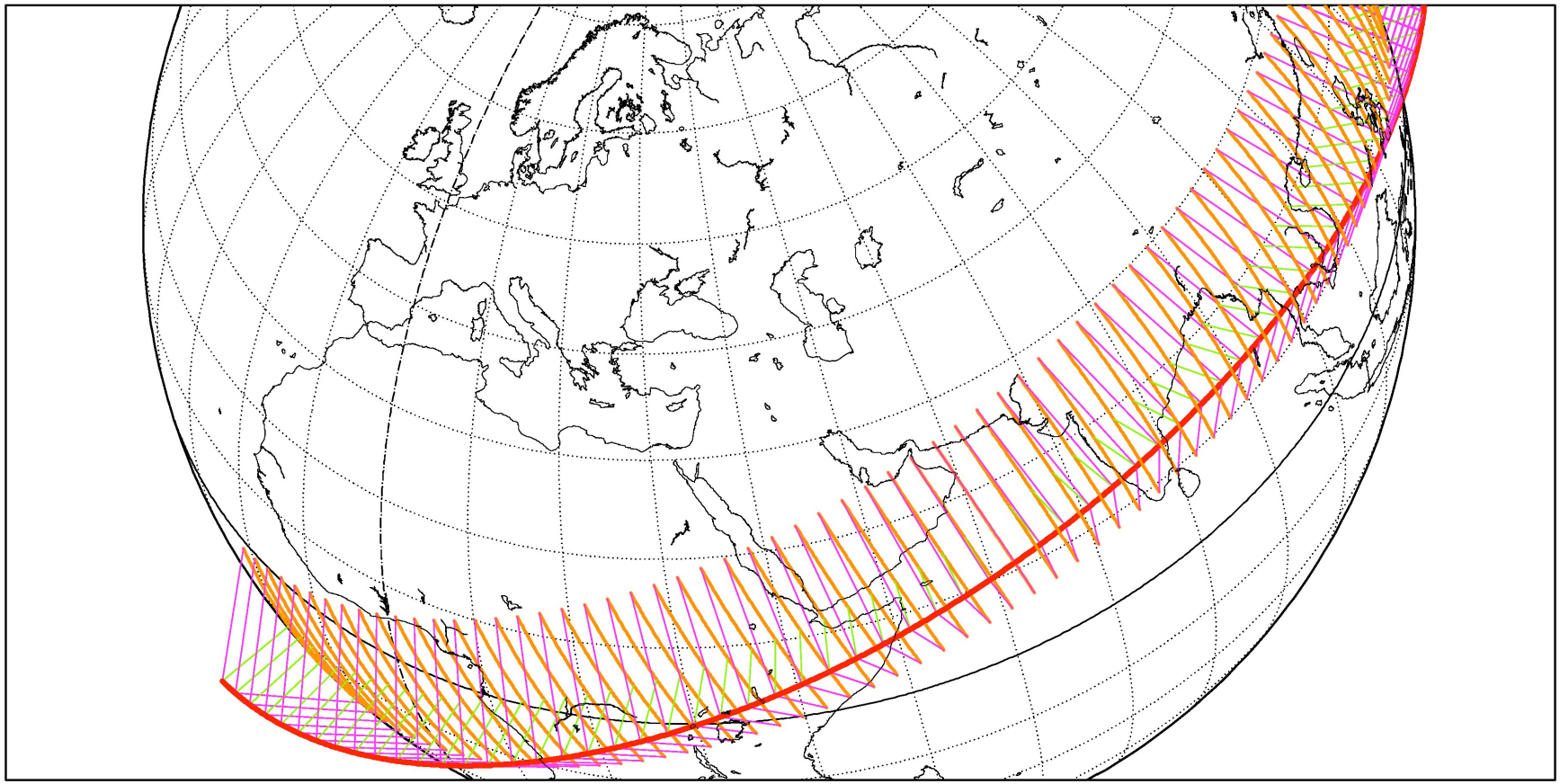
Period = 101.93 min * rev/day =14.13

>>>> Time span shown: 60.0 min = 0.04 day

Equat. orbital shift = 2892.0 km (26.0 °)

Across track swath (XT mode)

** Half-swath: 48.9° => 1108 km [0.75 min]



Projection: Orthographic

Property: none

⊕ T.:Azimuthal - Graticule: 10°

PC: 50.0 ° N; 50.0 °E /ZC: 35.0 ° N; 45.0 ° E

Aspect: Oblique

{5.3}[-90.0/ +40.0/ +40.0] [+16] EIGEN-C3

Asc. Node: 12.00 ° [12:00 LMT]

Max. attained latit. = 30.0 °

Ιξιων

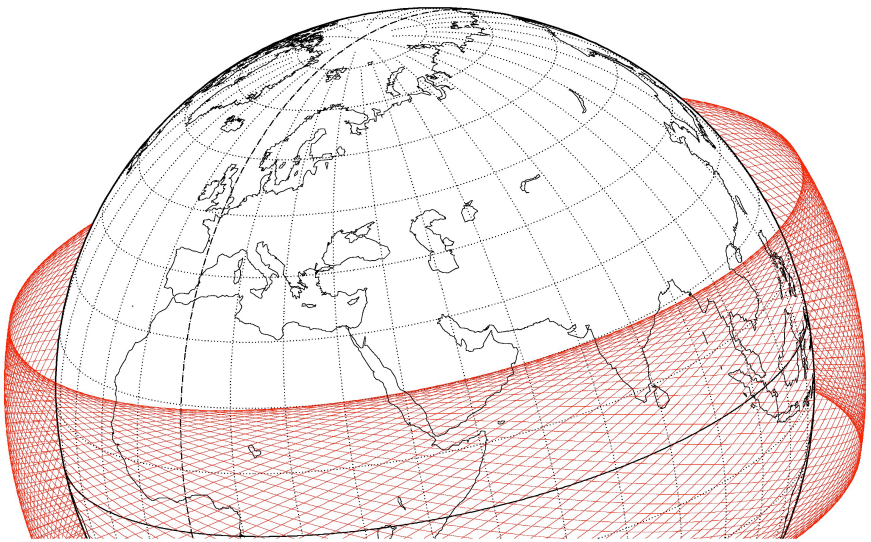
MC ★ LMD

Ατλας

The Orbit of ***Megha-Tropiques*** and Consequences for the Sampling

- 1 – Precession of the Orbital Plane
  (Cycle w.r.t. the Sun)
- 2 – Sampling for the Tropical Zone
- 3 – Comparison with the Sun-Synchr. Satellites
- 4 – Overlapping MT and Terra
- 5 – Occurrence of Sun-glint
- 6 – Repeat (revisit) cycle
  (Cycle w.r.t. Ground-track)
- 7 – Actual Orbital Elements for MT s/c
  and Stationkeeping

MT Orbit: characteristics



0

Megha-Tropiques
Orbit - ref.: Earth

Altitude = 865.5 km a = 7243.677 km

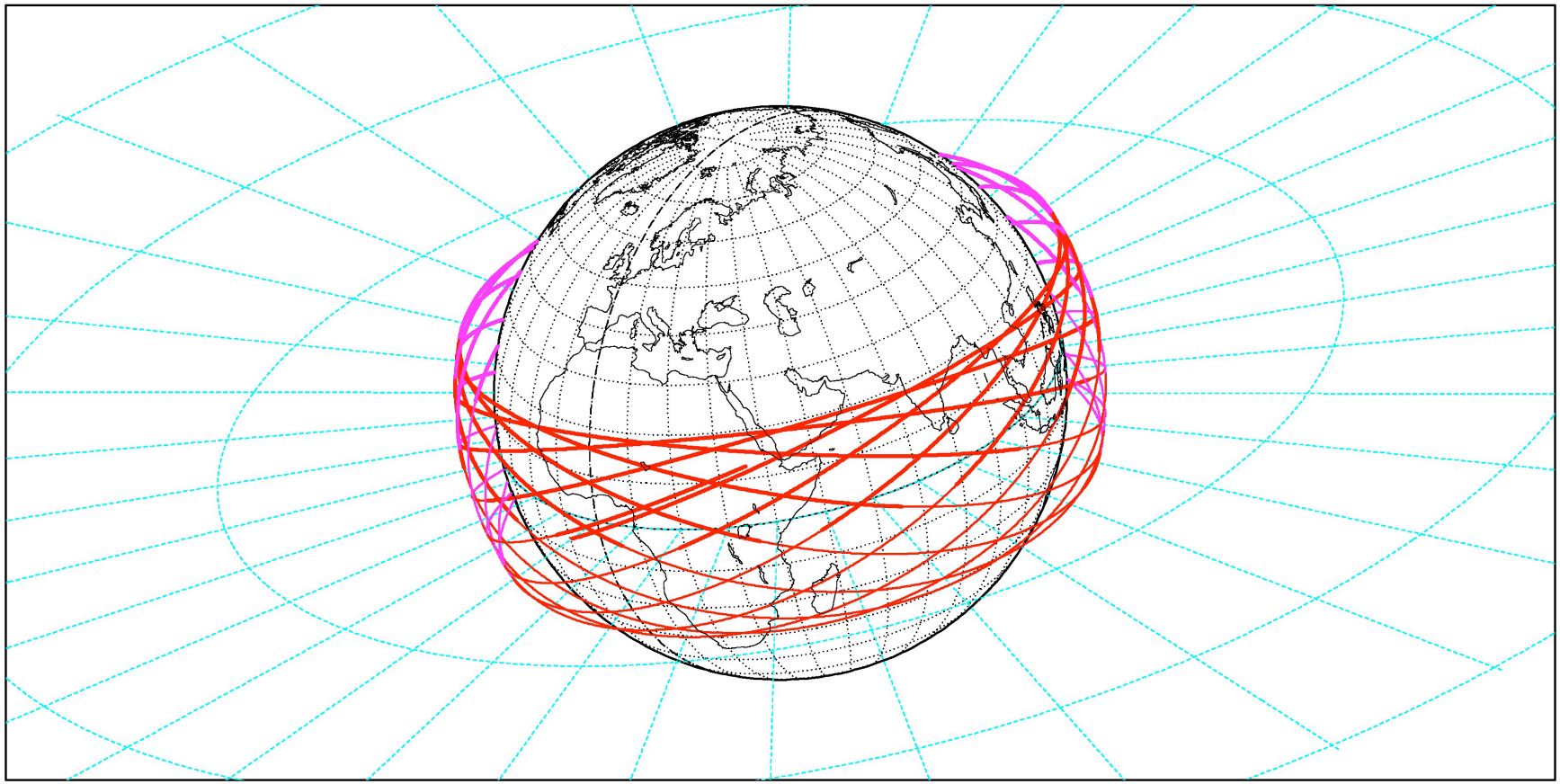
Inclination = 20.00 °

Recurrence = [14; -1; 7] 97

Period = 101.93 min * rev/day =14.13

>>>> Time span shown: 1440.0 min = 1.00 day

Equat. orbital shift = 2892.0 km (26.0 °)



Projection: Orthographic Project. centre: 26.0 ° N; 46.0 °E Asc. Node: 0.00 °

Property: none Aspect: Oblique

⊕ T.:Azimuthal - Graticule: 10° {4.2}[-90.0/ +64.0/ +44.0] [+12] EIGEN-C3

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques
Orbit - ref.: Earth

Altitude = 865.5 km a = 7243.677 km

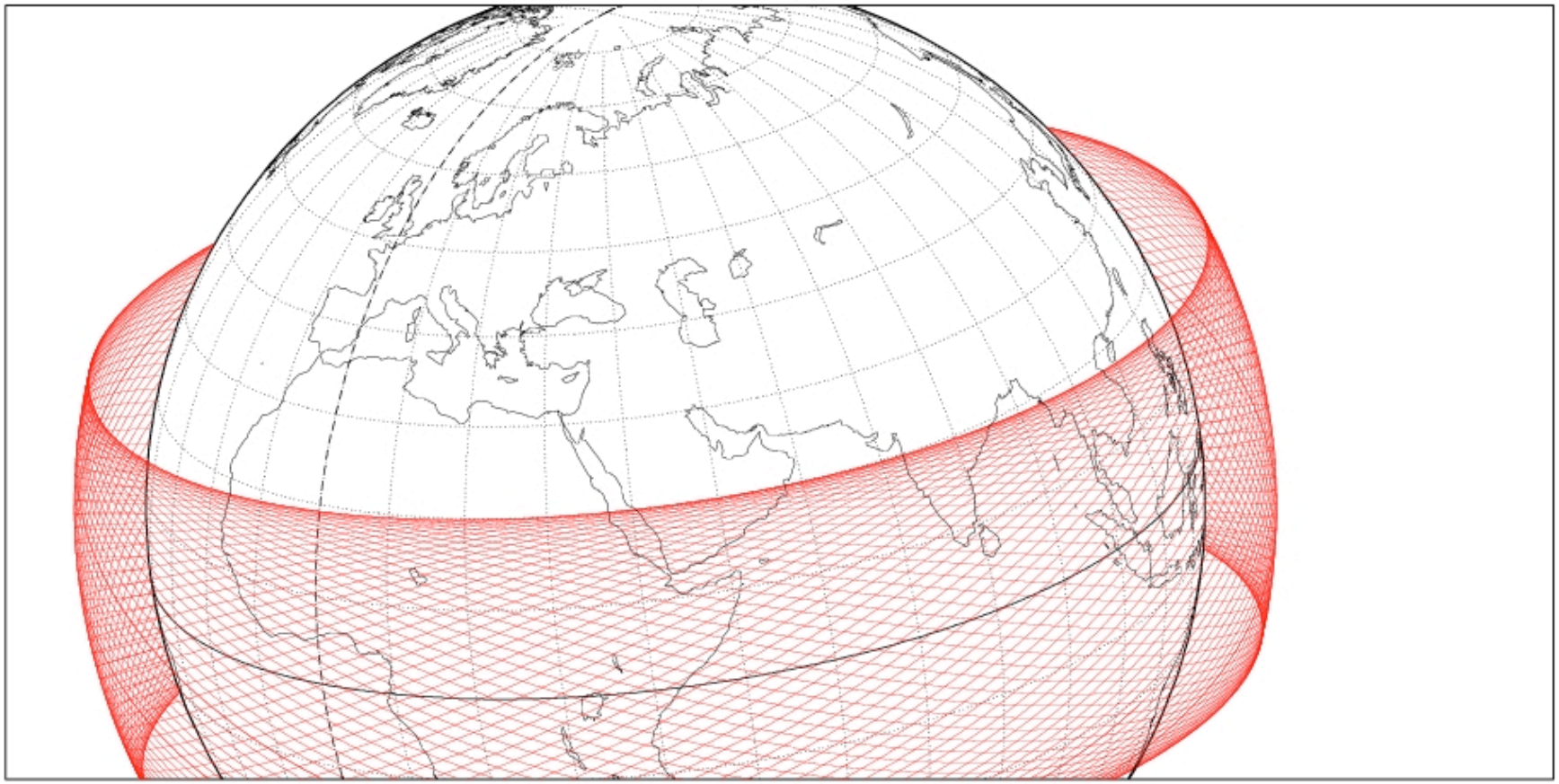
Inclination = 20.00 °

Recurrence = [14; -1; 7] 97

Period = 101.93 min * rev/day =14.13

>>>> Time span shown: 7.00 days

Equat. orbital shift = 2892.0 km (26.0 °)



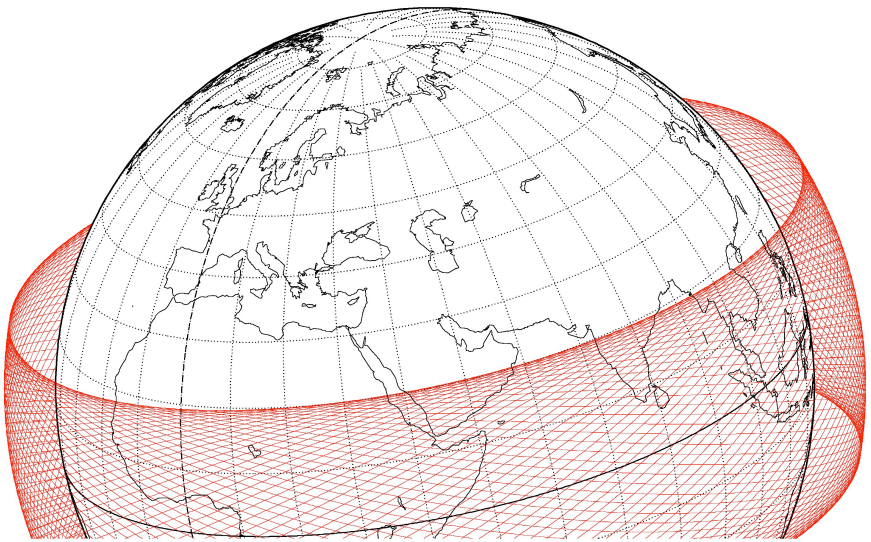
Projection: Orthographic PC: 20.0 ° N; 45.0 °E /ZC: 30.0 ° N; 60.0 ° E Asc. node: -180.00 ° [00:00 LMT]

Property: none Aspect: Oblique

⊕ T.:Azimuthal - Graticule: 10° {4.2} [-90.0/ +70.0/ +45.0] [+8] EIGEN-C3

Ιξιων
MC ★ LMD
Ατλας

Precession of the Orbital Plane (Cycle w.r.t. the Sun)

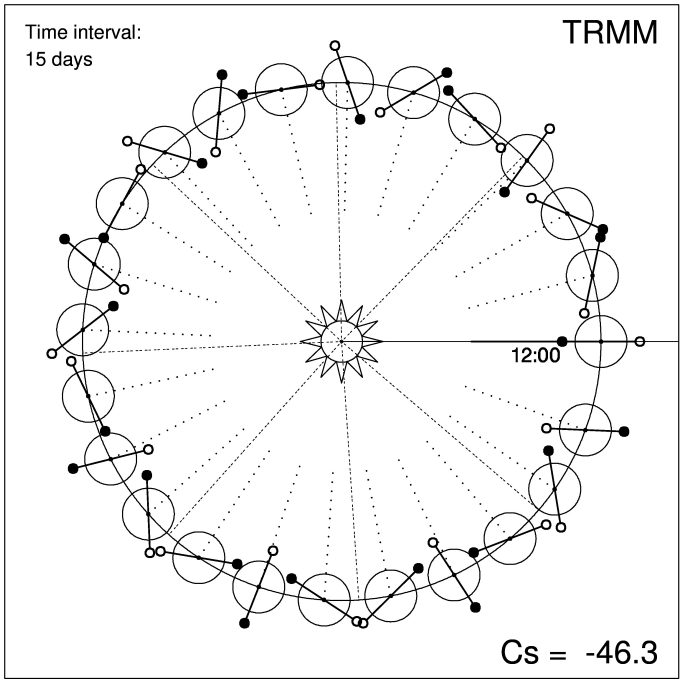


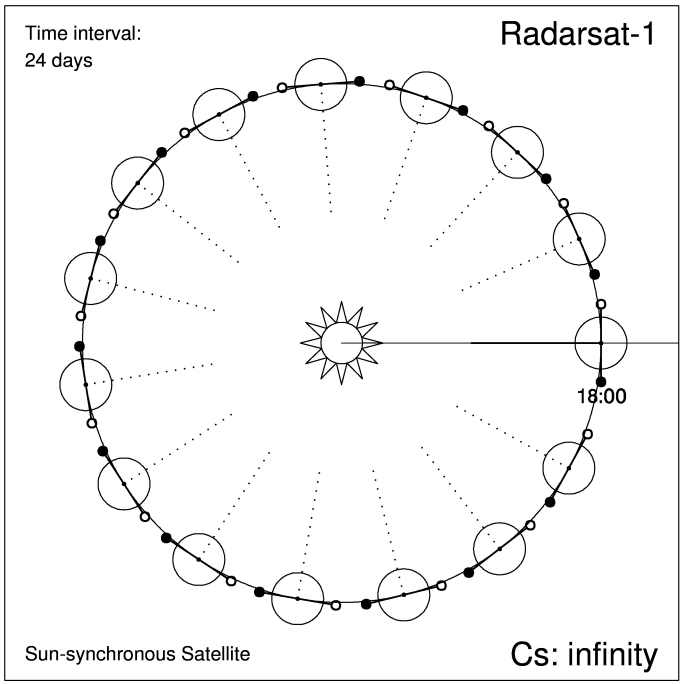
1

Line of nodes and **LMT**

Line between
ascending node and descending node :
intersection of
equatorial plane and
orbital plane.

The angle
(called hour angle)
between the line of nodes and
the direction Earth-Sun gives the
equatorial crossing time
LMT (Local Mean Solar Time)





Nodal precession

The orbital plane rotates uniformly about the polar axis with a constant angular speed, due to the non-sphericity of the Earth (J_2 term).

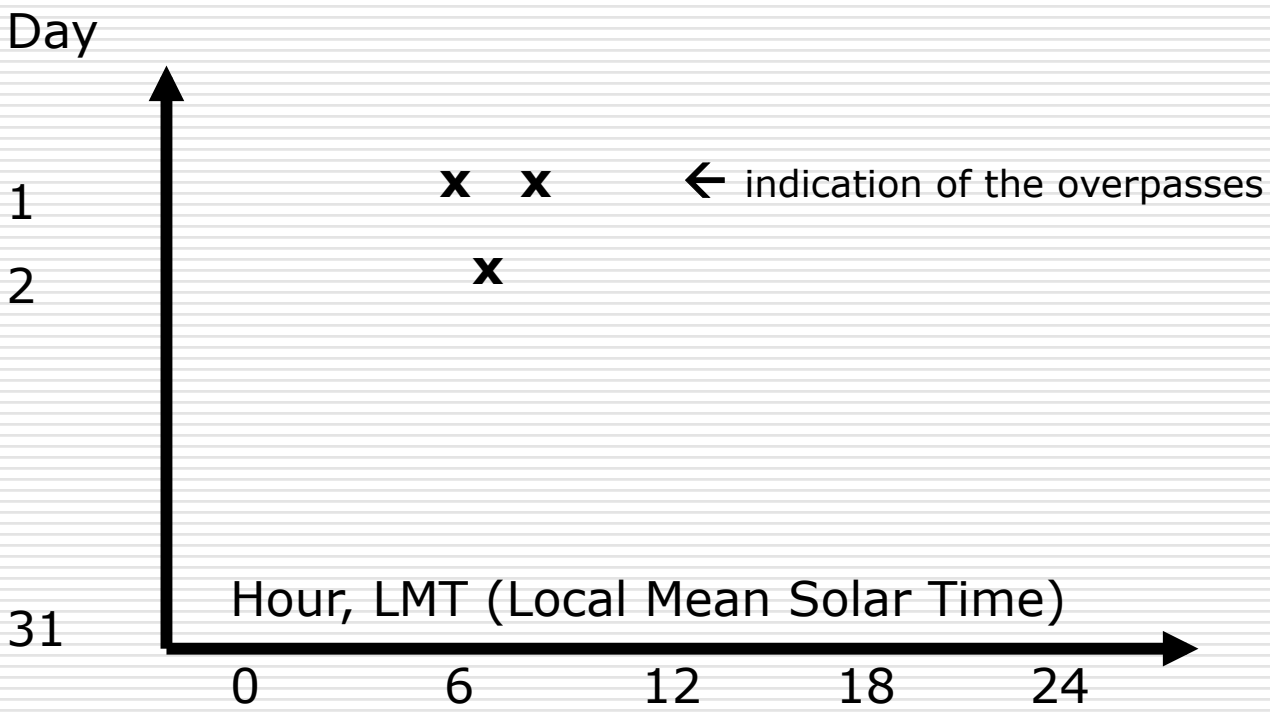
This motion is known as nodal precession.

For MT, this nodal precession rate is important:

the line of node made a full turn w.r.t. the direction of the Sun in **51 days.**

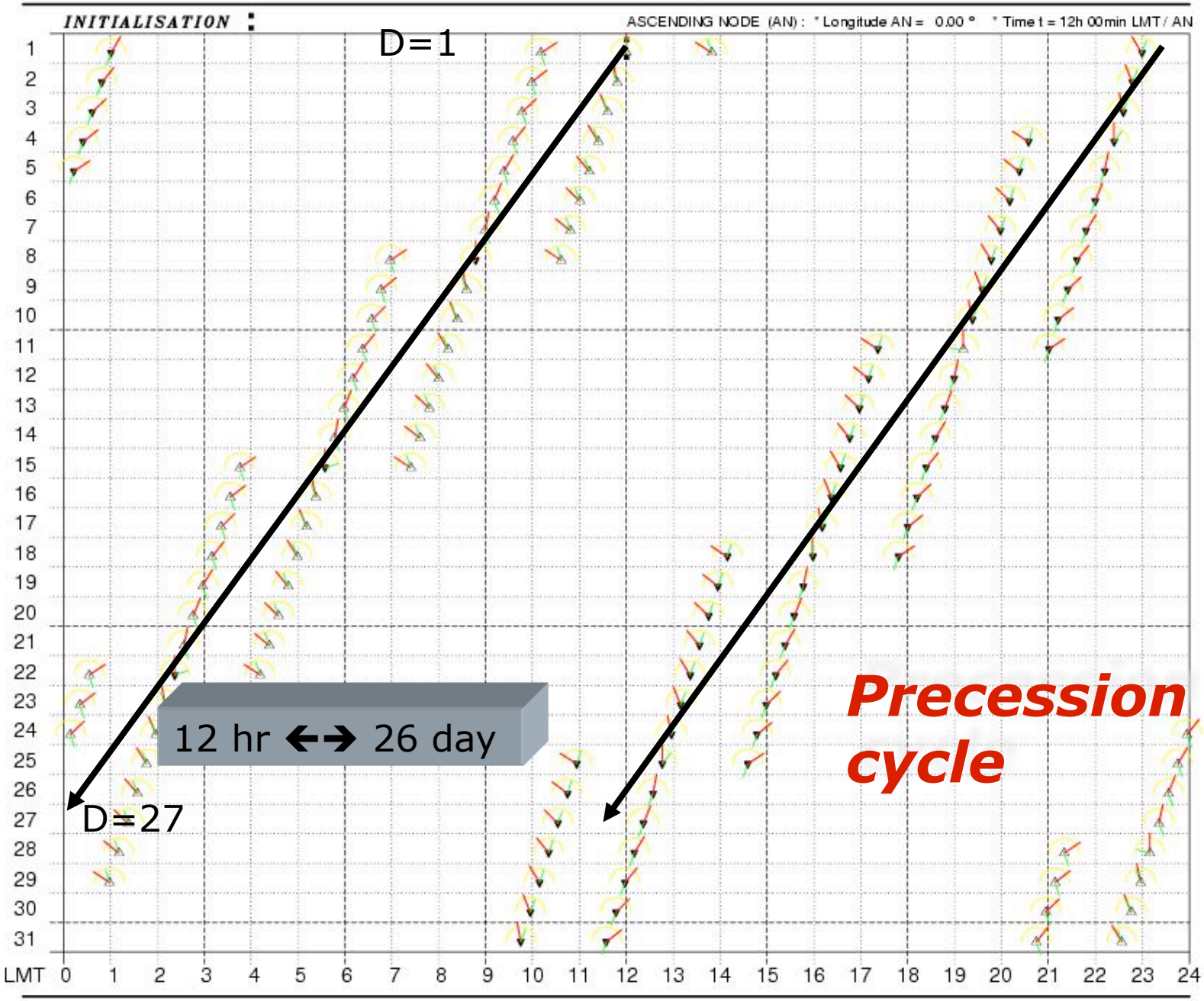
Monthly table

For a given location



Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
***

Megha-Trop. / ScaRaB



0 °

MONTHLY TABLE

OVERPASSES (n = 136)
OF SATELLITE S [GEM-T2]
FOR POINT P
- Latitude : 0.0 °
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

FIELD OF VIEW : 97.8 °

(1) (2) P-S DIRECTION
△ ASC ▼ DES

Right-handed system

- Zenith angle (in the plane orthogonal to the track). (1)
- Azimuth (in the local horizontal plane) (2) with respect to the North.

ORBIT a = 7243.700 km
Altitude = 865.6 km
Inclination = 20.00 °
Equatorial shift= 2892.0 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

SCANNING
Half-swath = 48.9 °
Maximal zenith angle = 58.9 °
H.-swath (ground) = 1108.3 km
Equatorial overlap = 2.089
Max. attained latit. = 30.0 °

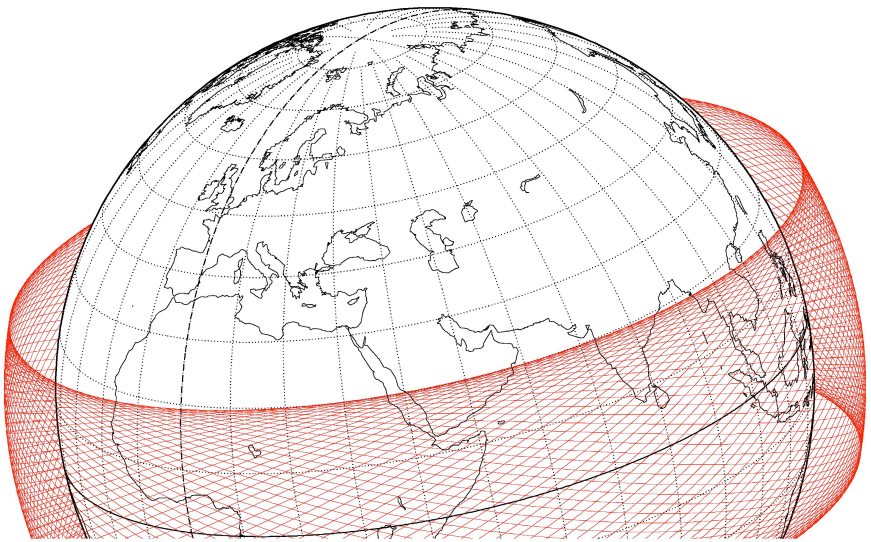
Ιξιων
MC ★ LMD

Precession Cycle

The time interval needed for
the hour angle of ascending node
to vary by 24 hr.

- For Megha-Tropiques,
the precession cycle is short : ***51 days***

Sampling
for the Tropical Zone



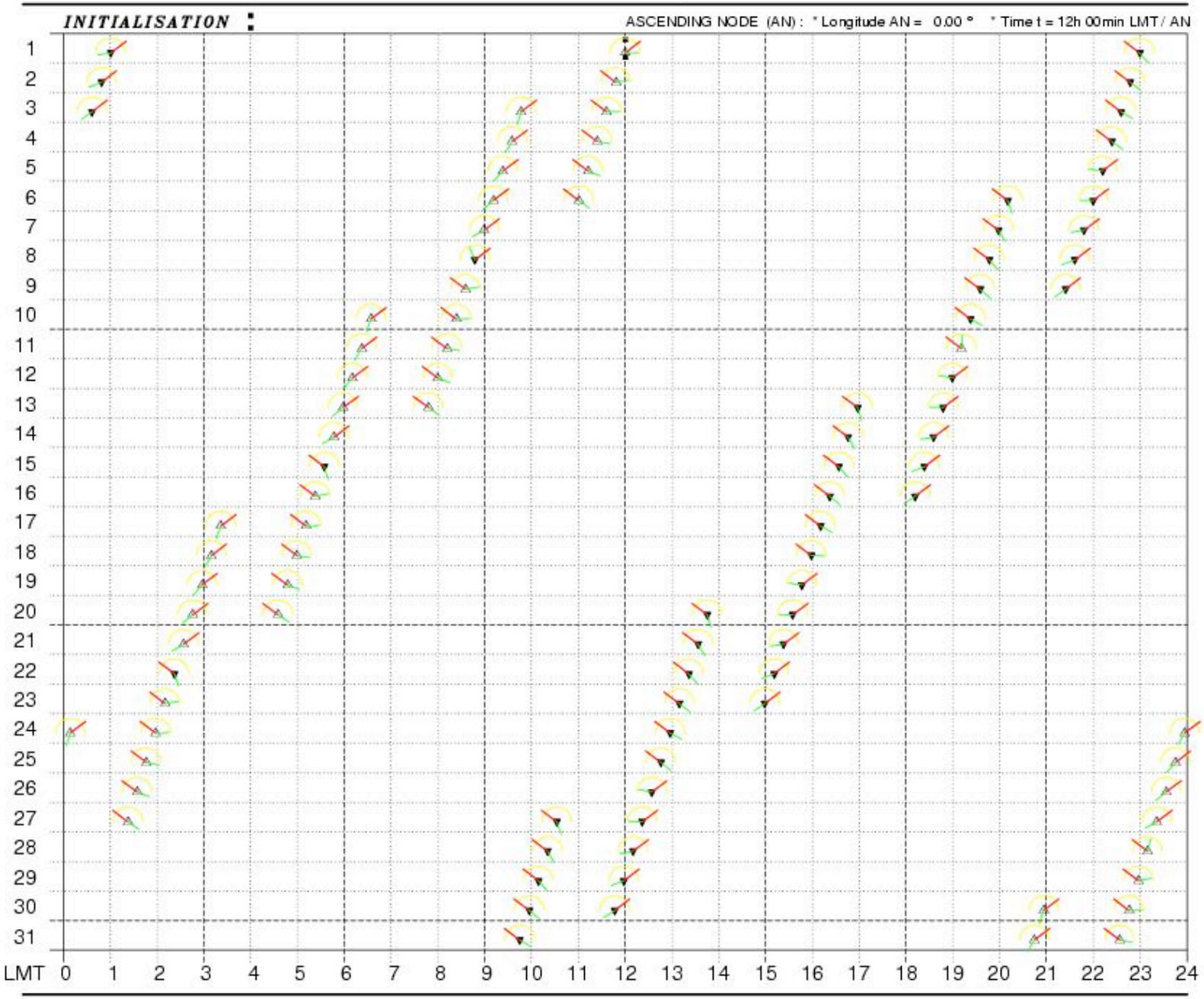
2

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
***

Megha-Trop. / MADRAS

0 °

MONTHLY TABLE



OVERPASSES (n = 100)
OF SATELLITE S [GEM-T2]
FOR POINT P
- Latitude : 0.0 °
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

APERTURE / FW : 130.0 °

(1) (2) P-S DIRECTION
△ ASC ▼ DES

Right-handed system

- Zenith angle: (1)
constant.

- Azimuth (in the local horizontal plane) (2)
with respect to the North.

ORBIT a = 7243.700 km
Altitude = 865.6 km
Inclination = 20.00 °
Equatorial shift= 2892.0 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

CONICAL SCANNING
Half-swath:
- equivalent (angle)= 42.3 °
- equiv.(ground) 841.0 km
CONICAL zen. angle = 53.1 °
Max. attained latit. = 27.6 °

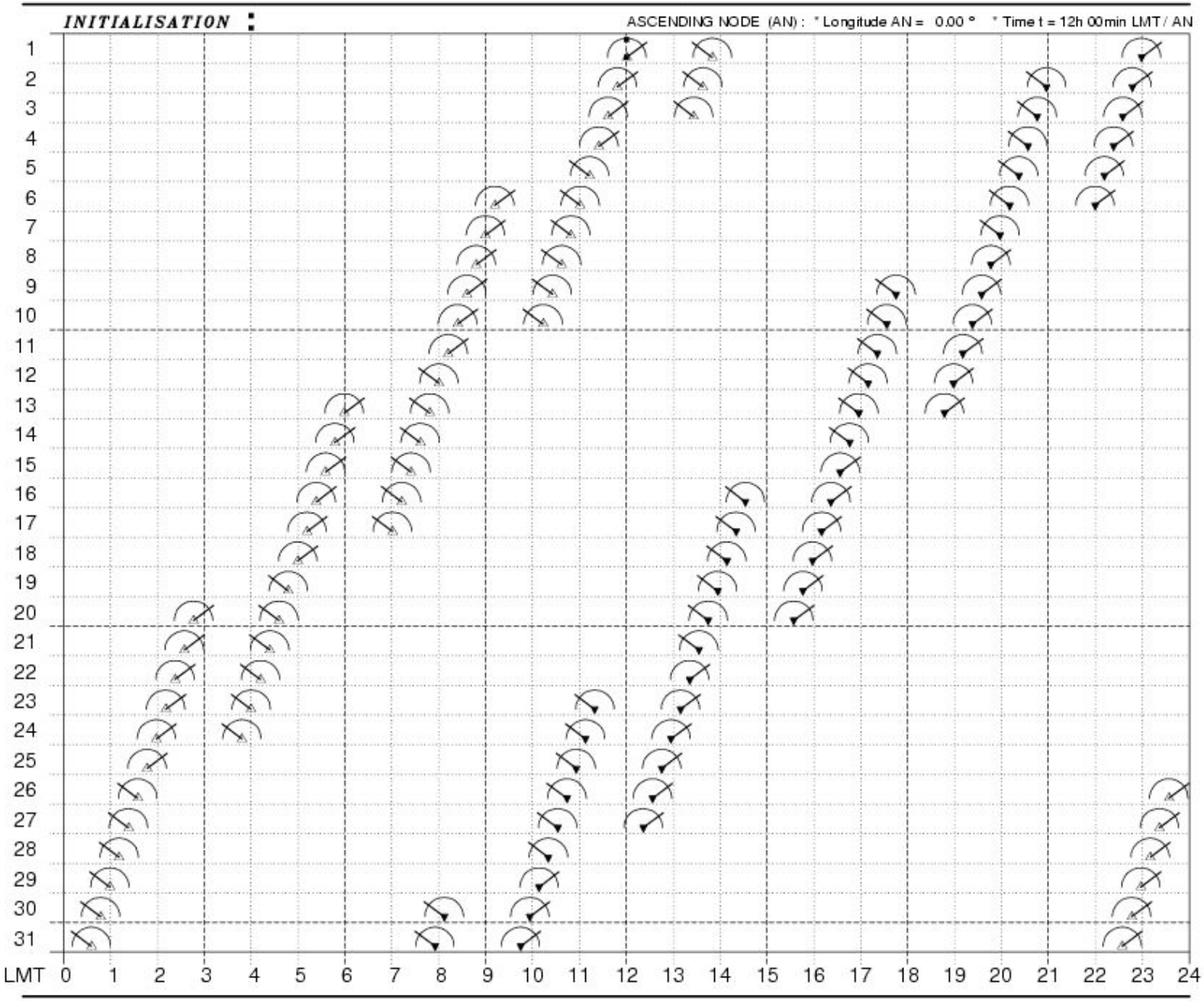
Ιξιων
MC ★ LMD

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
***

Megha-Trop. / MADRAS

5 ° N

MONTHLY TABLE



OVERPASSES (n = 108)
OF SATELLITE S [GEM-T2]
FOR POINT P
- Latitude : 5.0 ° N
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

APERTURE / FW : 130.0 °

(1) P-S DIRECTION
△ ASC ▼ DES

Zenith angle of PS:
constant angle.

(1)
In the plane orthog.
to the track:
Right-handed
system.

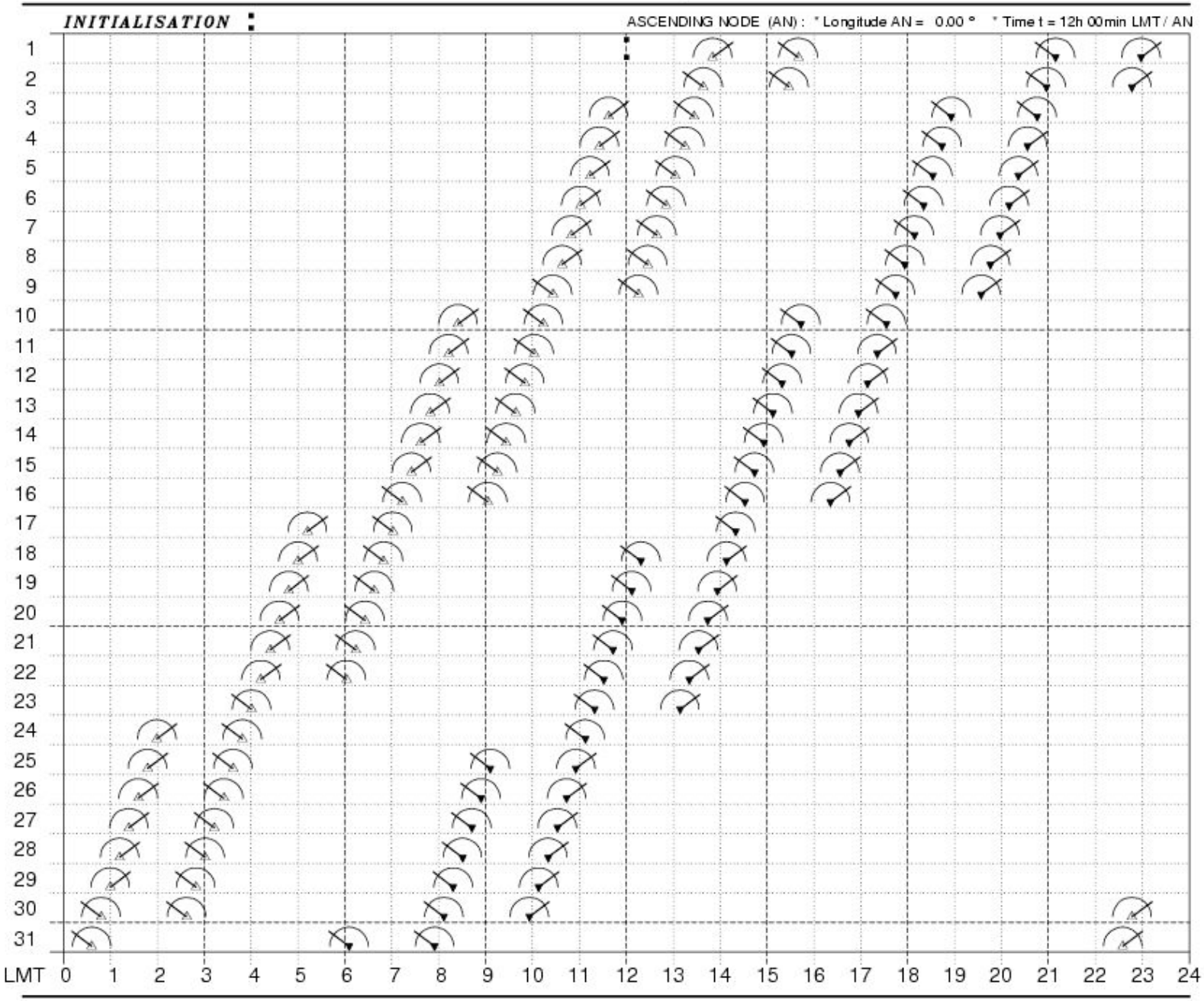
ORBIT a = 7243.700 km
Altitude = 865.6 km
Inclination = 20.00 °
Equatorial shift= 2892.0 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

CONICAL SCANNING
Half-swath:
- equivalent (angle)= 42.3 °
- equiv.(ground) 841.0 km
CONICAL zen. angle = 53.1 °
Max. attained latit. = 27.6 °

Ιξιων
MC ★ LMD

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
***

Megha-Trop. / MADRAS



10 ° N

MONTHLY TABLE

OVERPASSES (n = 122)
OF SATELLITE S [GEM-T2]
FOR POINT P
- Latitude : 10.0 ° N
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

APERTURE / FW : 130.0 °

(1) P-S DIRECTION
△ ASC ▼ DES

Zenith angle of PS:
constant angle.

(1)
In the plane orthog.
to the track:
Right-handed
system.

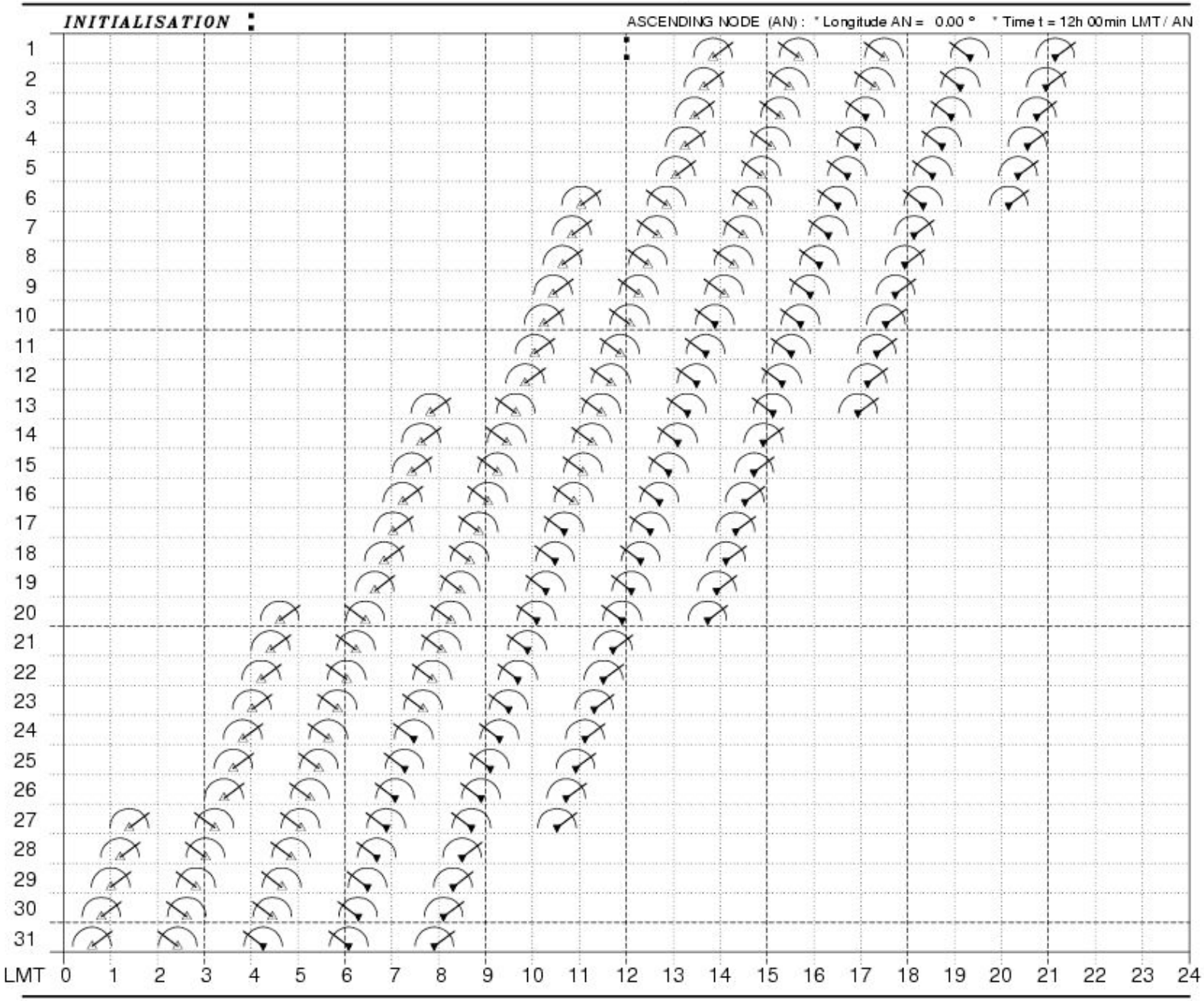
ORBIT a = 7243.700 km
Altitude = 865.6 km
Inclination = 20.00 °
Equatorial shift= 2892.0 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

CONICAL SCANNING
Half-swath:
- equivalent (angle)= 42.3 °
- equiv.(ground) 841.0 km
CONICAL zen. angle = 53.1 °
Max. attained latit. = 27.6 °

Ιξιων
MC ★ LMD

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
***

Megha-Trop. / MADRAS



15 ° N MONTHLY TABLE

OVERPASSES (n = 159)
OF SATELLITE S [GEM-T2]
FOR POINT P
- Latitude : 15.0 ° N
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

APERTURE / FW : 130.0 °

(1) P-S DIRECTION
△ ASC ▼ DES

Zenith angle of PS:
constant angle.

(1)
In the plane orthog.
to the track:
Right-handed
system.

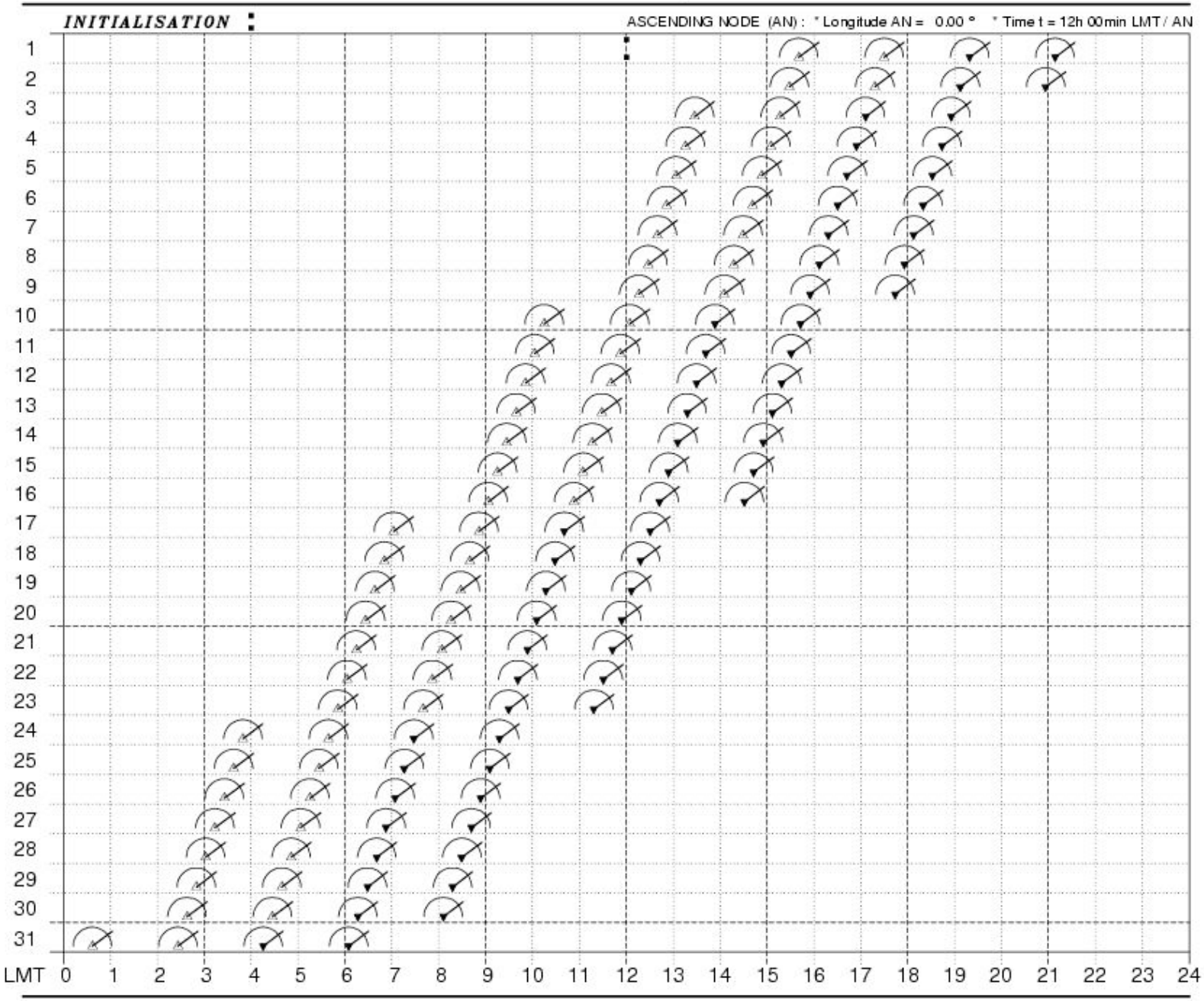
ORBIT a = 7243.700 km
Altitude = 865.6 km
Inclination = 20.00 °
Equatorial shift= 2892.0 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

CONICAL SCANNING
Half-swath:
- equivalent (angle)= 42.3 °
- equiv.(ground) 841.0 km
CONICAL zen. angle = 53.1 °
Max. attained latit. = 27.6 °

Ιξιων
MC ★ LMD

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
***

Megha-Trop. / MADRAS



20 ° N

MONTHLY TABLE

OVERPASSES (n = 124)
OF SATELLITE S [GEM-T2]
FOR POINT P
- Latitude : 20.0 ° N
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

APERTURE / FW : 130.0 °

(1) P-S DIRECTION
△ ASC ▼ DES

Zenith angle of PS:
constant angle.

(1)
In the plane orthog.
to the track:
Right-handed
system.

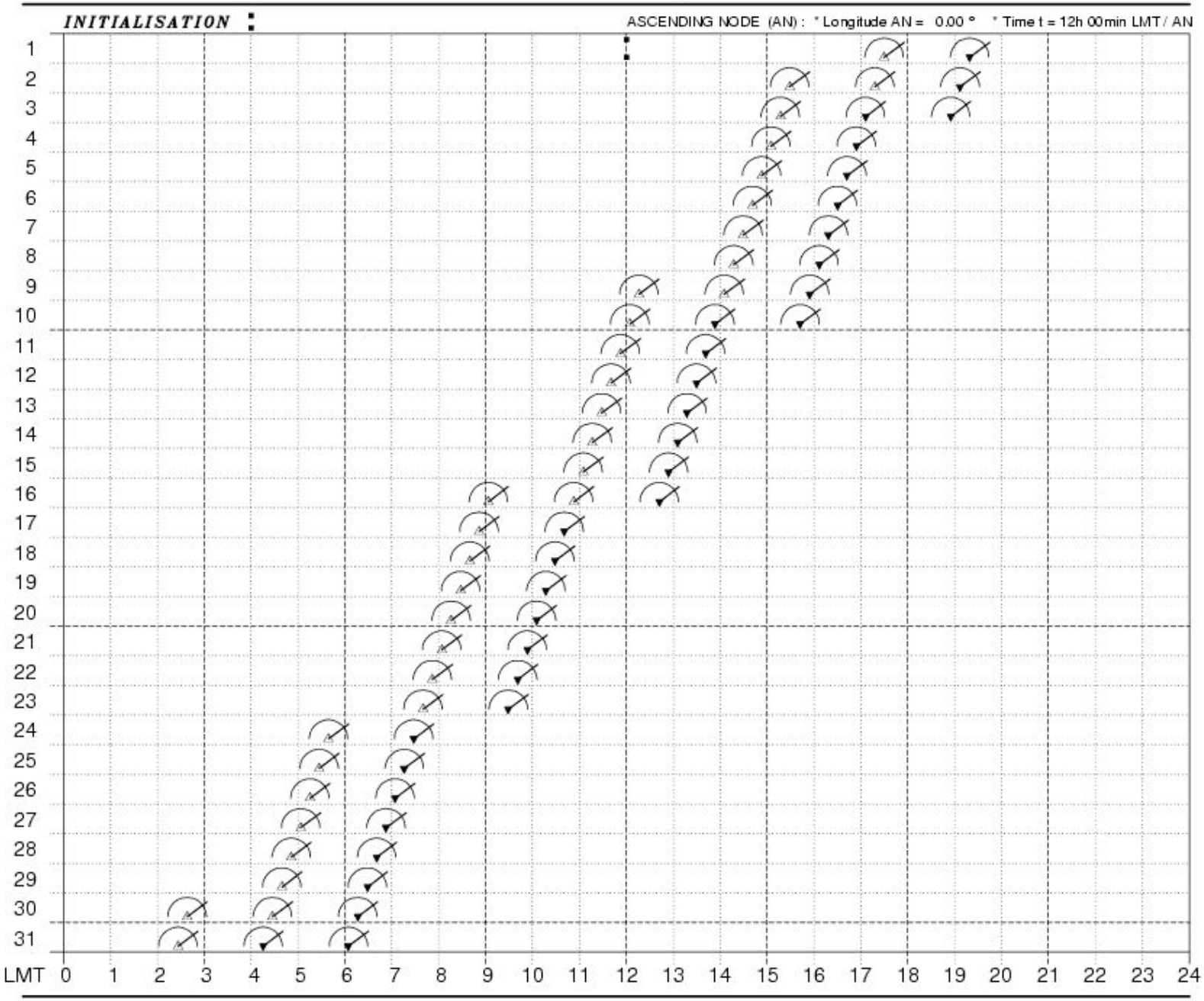
ORBIT a = 7243.700 km
Altitude = 865.6 km
Inclination = 20.00 °
Equatorial shift= 2892.0 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

CONICAL SCANNING
Half-swath:
- equivalent (angle)= 42.3 °
- equiv.(ground) 841.0 km
CONICAL zen. angle = 53.1 °
Max. attained latit. = 27.6 °

Ιξιων
MC ★ LMD

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
***

Megha-Trop. / MADRAS



25 ° N

MONTHLY TABLE

OVERPASSES (n = 69)
OF SATELLITE S [GEM-T2]
FOR POINT P
- Latitude : 25.0 ° N
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

APERTURE / FW : 130.0 °

(1) P-S DIRECTION
△ ASC ▼ DES

Zenith angle of PS:
constant angle.

(1)
In the plane orthog.
to the track:
Right-handed
system.

ORBIT a = 7243.700 km
Altitude = 865.6 km
Inclination = 20.00 °
Equatorial shift= 2892.0 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

CONICAL SCANNING
Half-swath:
- equivalent (angle)= 42.3 °
- equiv.(ground) 841.0 km
CONICAL zen. angle = 53.1 °
Max. attained latit. = 27.6 °

Ιξιων
MC ★ LMD

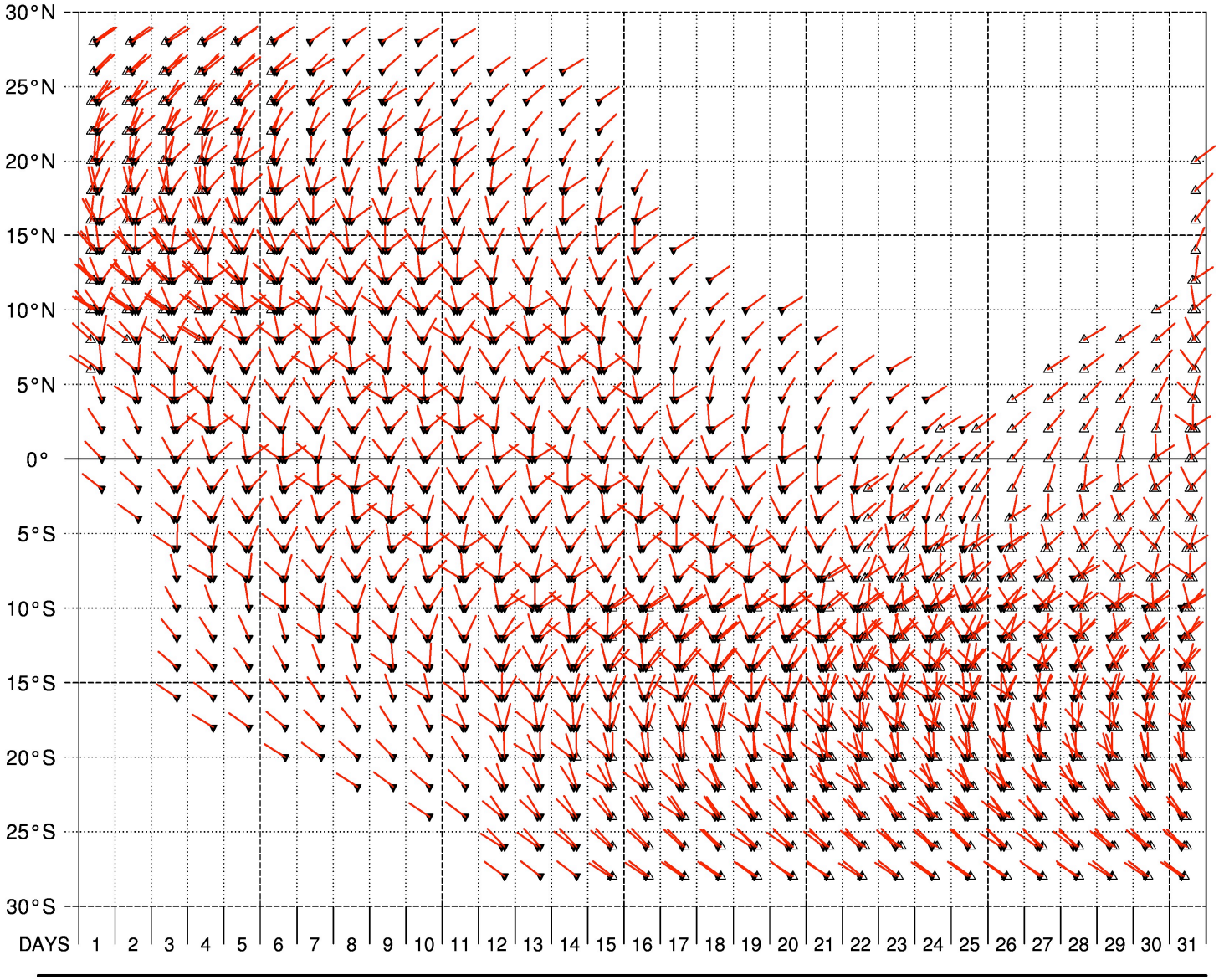
- Particular point,

resulting of the 20-degree inclination:
for the latitudes between 12° and 25°
(North and South),
the ***temporal sampling*** is represented by
- a « pack » of overpasses
- followed by a « lack » (without overpass).

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
* J=1 (Yr Mn Dy)* [T] 2012 10 01

Megha-Tropiques

INITIALISATION ASCENDING NODE (AN) : * Longitude AN = 158.56 °E * Date = 2012 10 01 * Time = 04h 41min LMT / AN



07:00-17:00

Time (LMT) slot

MONTHLY TABLE

[T] : Track

OVERPASSES
OF SATELLITE S [EIGEN-C3]
FOR POINT P
AS FUNCTION OF THE LATITUDE.
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

FIELD OF VIEW : 97.8 °

(1) P-S DIRECTION
△ ASC ▼ DES

Zenith angle of PS:
in the plane
orthogonal (1)
to the track.

Right-handed
system.

ORBIT a = 7243.532 km
Altitude = 865.4 km
Inclination = 19.97 °
Equatorial shift= 2891.9 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

SCANNING
Half-swath = 48.9 °
Maximum zenith angle = 58.9 °
H.-swath (ground) = 1108.0 km
Equatorial overlap = 2.091
Max. attained latit. = 29.9 °

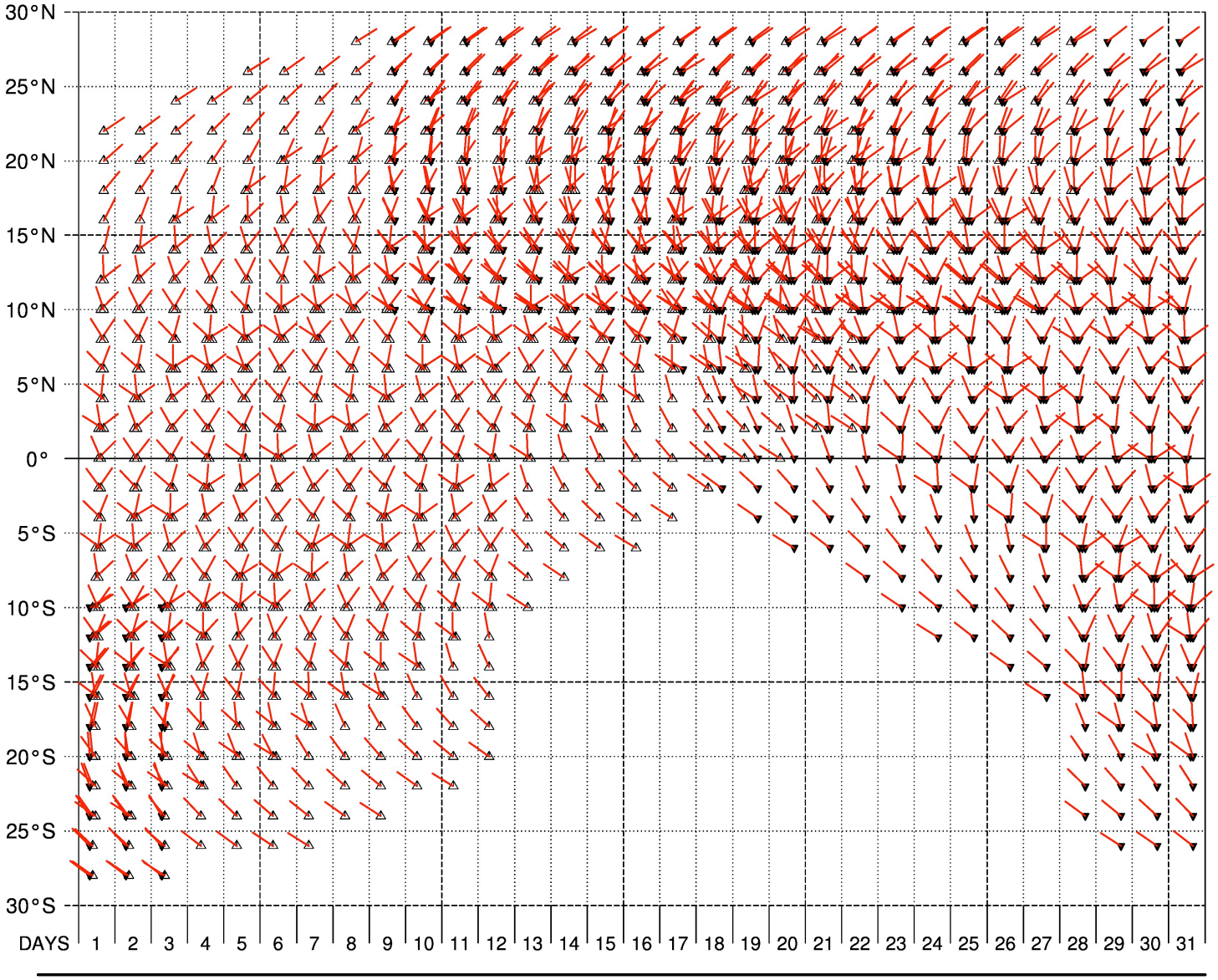
Ξιων

MC ★ LMD

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
* J=1 (Yr Mn Dy)* [T] 2012 11 01

Megha-Tropiques

INITIALISATION ASCENDING NODE (AN) : * Longitude AN = 177.20 °E * Date = 2012 10 17 * Time = 21h 22min LMT / AN



07:00-17:00

Time (LMT) slot

MONTHLY TABLE

[T] : Track

OVERPASSES
OF SATELLITE S [EIGEN-C3]
FOR POINT P
AS FUNCTION OF THE LATITUDE.
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

FIELD OF VIEW : 97.8 °

(1) P-S DIRECTION
△ ASC ▼ DES

Zenith angle of PS:
in the plane
orthogonal (1)
to the track.

Right-handed
system.

ORBIT a = 7243.522 km
Altitude = 865.4 km
Inclination = 19.97 °
Equatorial shift= 2891.9 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

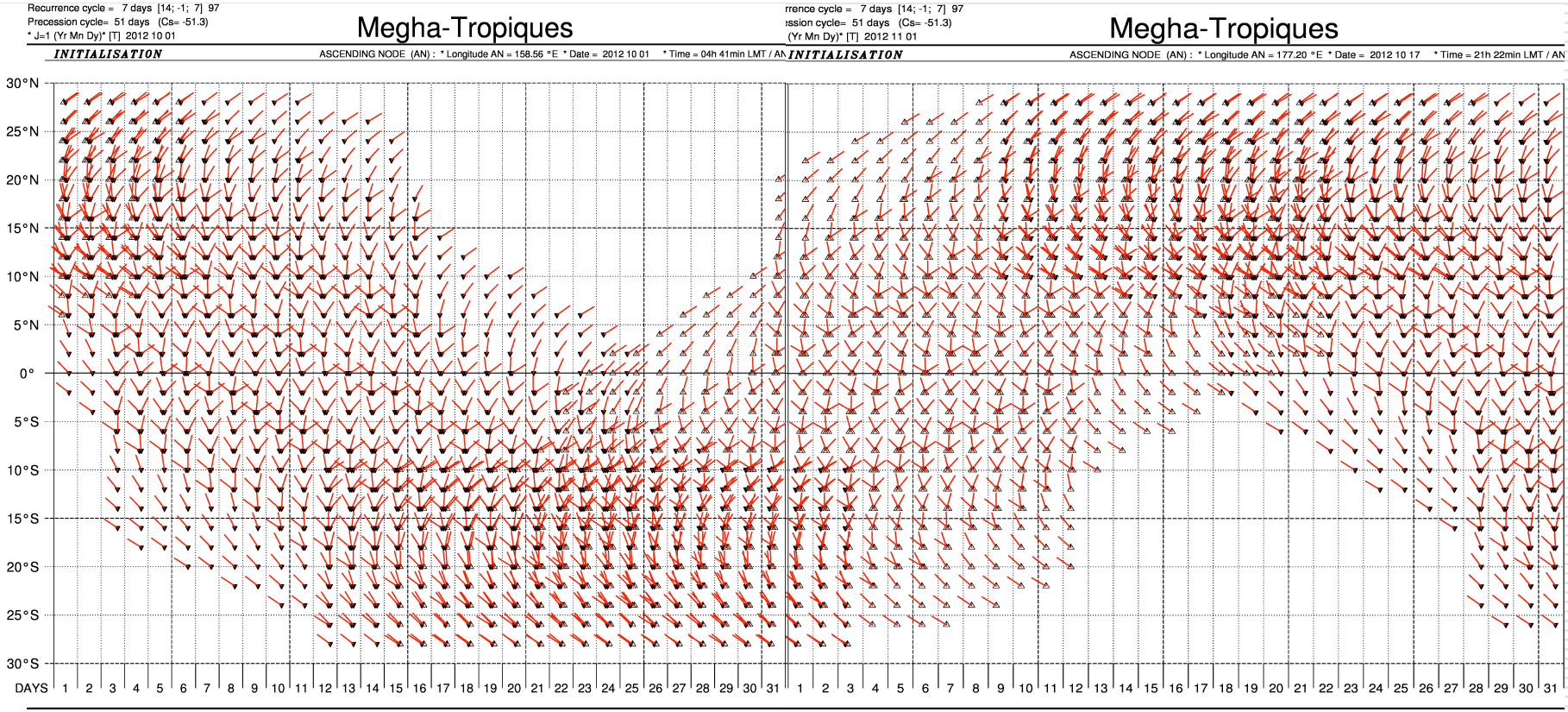
SCANNING
Half-swath = 48.9 °
Maximum zenith angle = 58.9 °
H.-swath (ground) = 1108.0 km
Equatorial overlap = 2.091
Max. attained latit. = 29.9 °

Ξιων

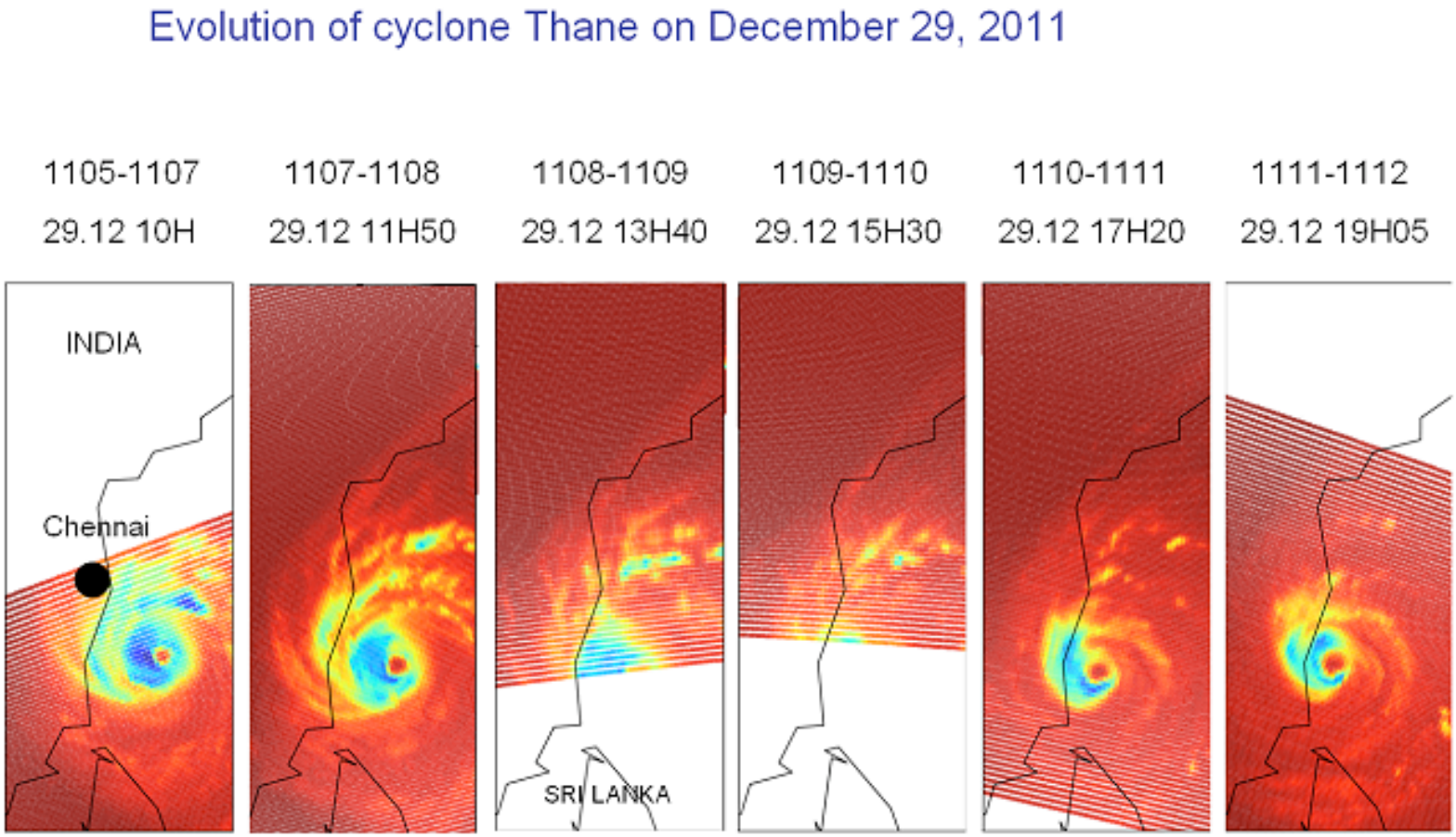
MC ★ LMD

Sampling for the interval **07:00 – 17:00**
(10 h. day-light between 7 am and 5 pm)

MT: **October** and **November** 2012



6 consecutive overpasses



Instrument SAPHIR

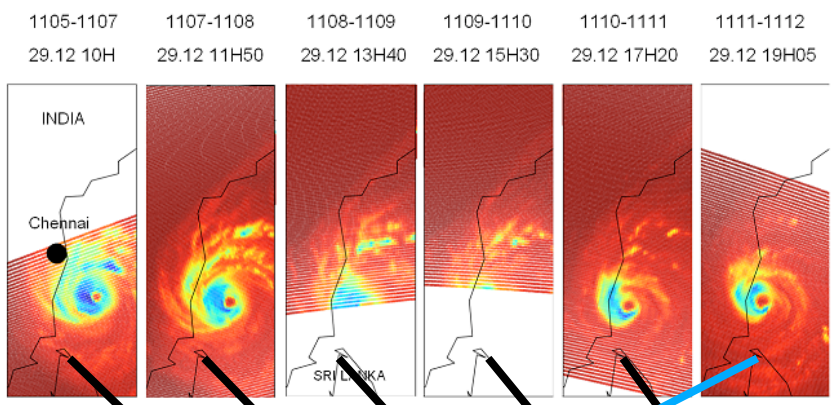
Cycle / Phasage = 7 jours [14; -1; 7] 97
Cycle / Soleil = 51 jours (Cs= -51.3)
* J=1 (An Mo Jr)* [T] 2011 12 01

Megha-Tropiques

12 ° N

TABLEAU MENSUEL

INITIALISATION [NORAD] NOEUD ASCENDANT (NA) : * Longitude NA = 143.70 °E * Date = 2011 12 29 * Instant = 14h 34min TSM / NA



TSM 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

[T] : Trace

PASSAGES (n = 166)
DU SATELLITE S [EIGEN-C3]
POUR LE POINT P
- Latitude : 12.0 ° N
- Longitude : 80.0 ° E
Pour P : TUC = TSM - 05h 20m

CHAMP DE VUE : 85.9 °

(1) (2) DIRECTION P-S
△ ASC ▼ DES

Sens trigonom. direct.

- Angle zénithal (dans le plan perpendiculaire à la trace). (1)

- Azimut (dans le plan horizontal local) par rapport au Nord. (2)

ORBITE a = 7243.615 km
Altitude = 865.5 km
Inclinaison = 19.98 °
Décalage équat. = 2892.0 km
Période = 101.93 min
Moyen mvt = 14.13 tours/j

BALAYAGE
Demi-fauchée = 43.0 °
Ang.Zénithal maximal = 50.7 °
D.-fauchée sol = 862.8 km
Fr. Recouvrement équat. = 1.628
Latit. max. atteinte = 27.7 °

Ιξιων
MC ★ LMD

Megha-Tropiques / MADRAS
Orbit - Ground track

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

Recurrence = [14; -1; 7] 97

Period = 101.93 min * rev/day =14.13

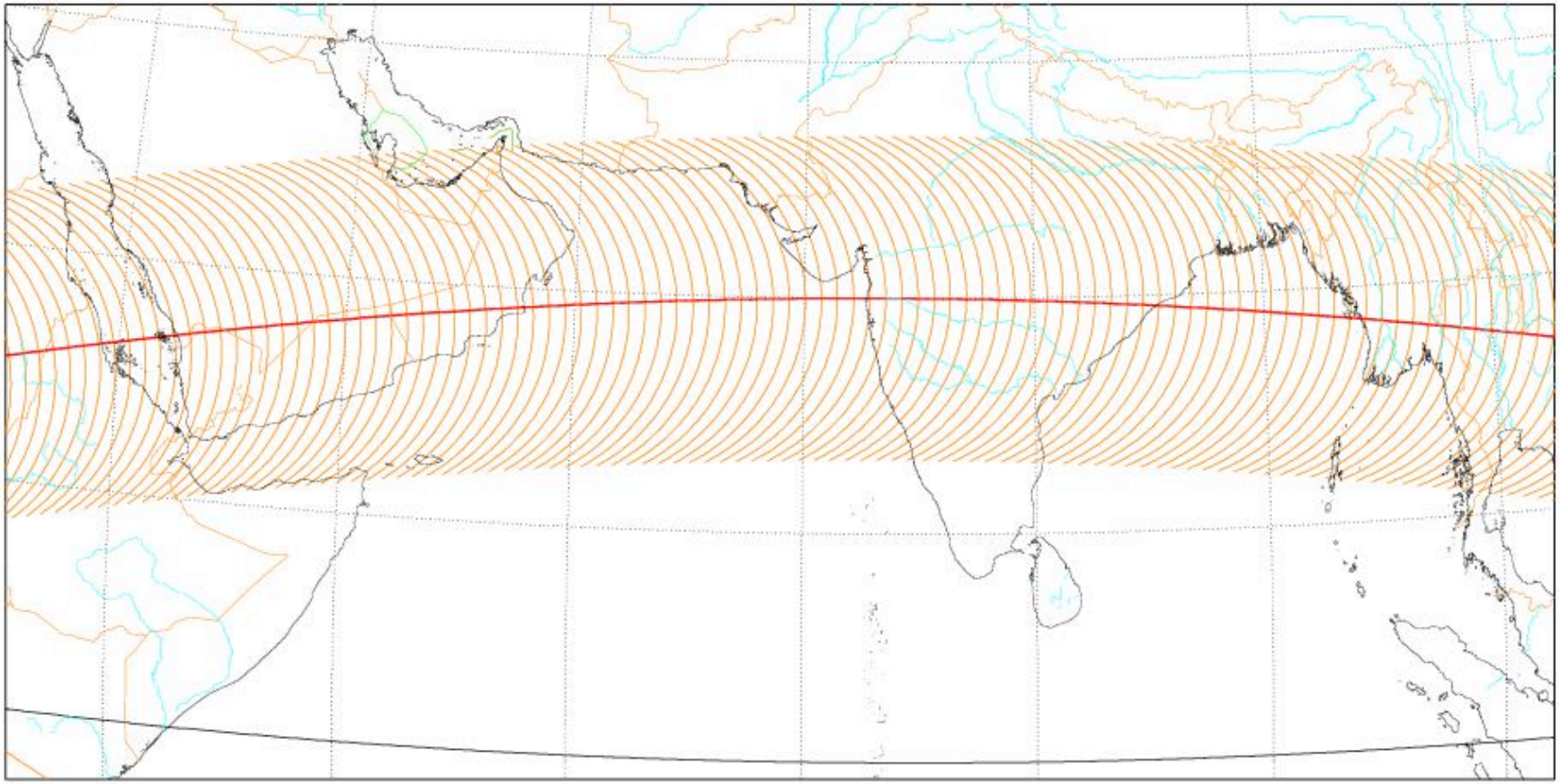
>>>> Time span shown: 100.0 min = 0.07 day

Equat. orbital shift = 2892.0 km (26.0 °)

Ground track - Conical swath / VZA=53.1 °

** Half-aperture: 65.0° - Radius/grnd 928 km [0.25 min]

** Effect. h-ap.: 42.3 ° => 841 km - Effect. swath: 1682 km



Projection: Raisz Armadillo

Property: none

⊕ T.:(various) - Graticule: 10°

MC: 0.0 ° ; 75.0 °E/ZC: 16.0 ° N; 69.0 ° E

Aspect: Direct **> zoom : 4.00**

{6.4} [+90.0/ +0.0/-165.0] [-] GEM-T2

Asc. node: -10.00 ° [00:00 LMT]

App. inclin. = 21.52 °

Max. attained latit. = 27.6 °

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques / ScaRaB
Orbit - Ground track

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

Recurrence = [14; -1; 7] 97

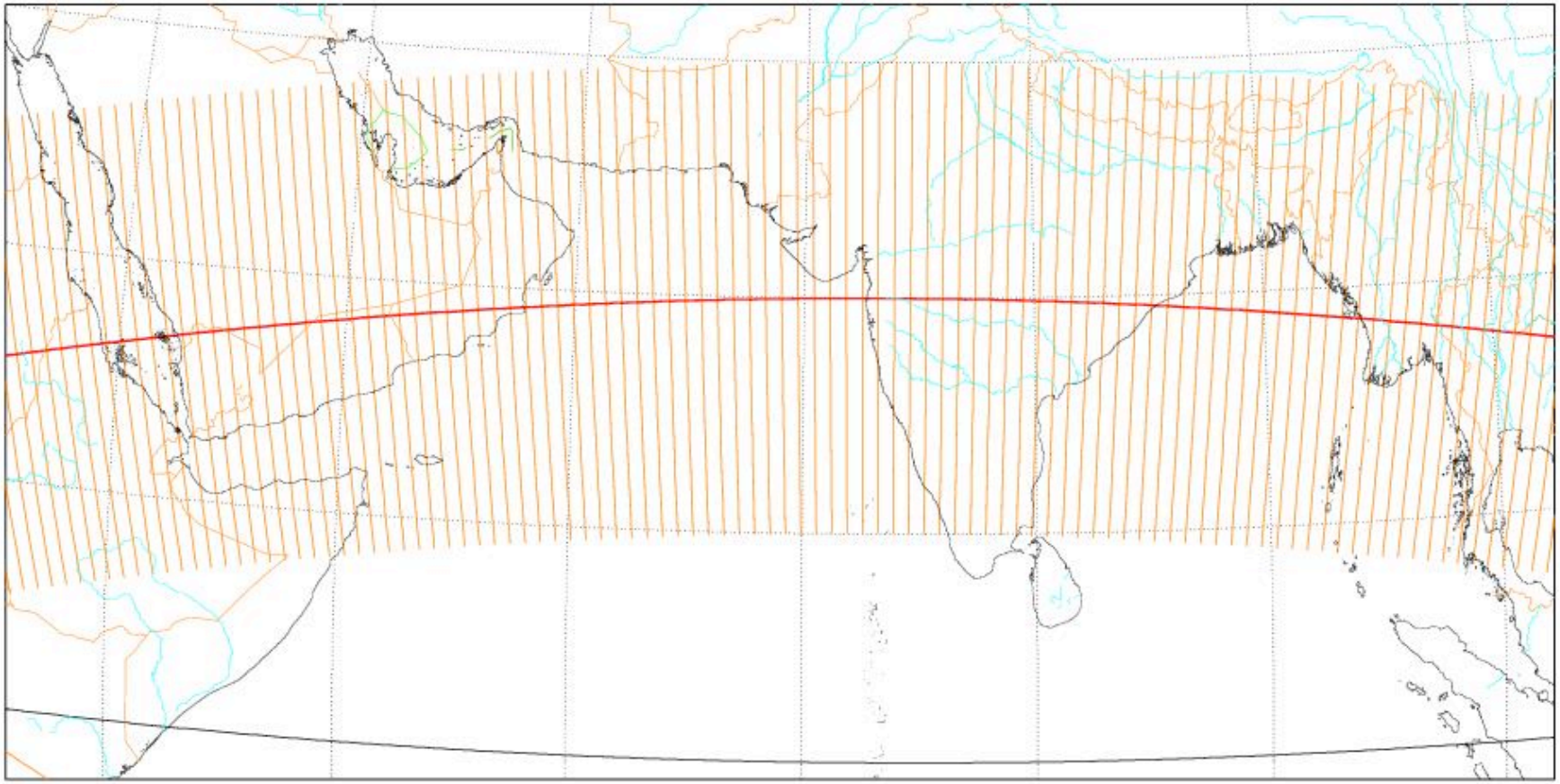
Period = 101.93 min * rev/day =14.13

>>>> Time span shown: 100.0 min = 0.07 day

Equat. orbital shift = 2892.0 km (26.0 °)

Across track swath (XT mode)

** Half-swath: 48.9° => 1108 km [0.25 min]



Projection: Raisz Armadillo

Property: none

⊕ T.:(various) - Graticule: 10°

MC: 0.0 ° ; 75.0 °E/ZC: 16.0 ° N; 69.0 ° E

Aspect: Direct **> zoom : 4.00**

{6.4} [+90.0/ +0.0/-165.0] [-] GEM-T2

Asc. node: -10.00 ° [00:00 LMT]

App. inclin. = 21.52 °

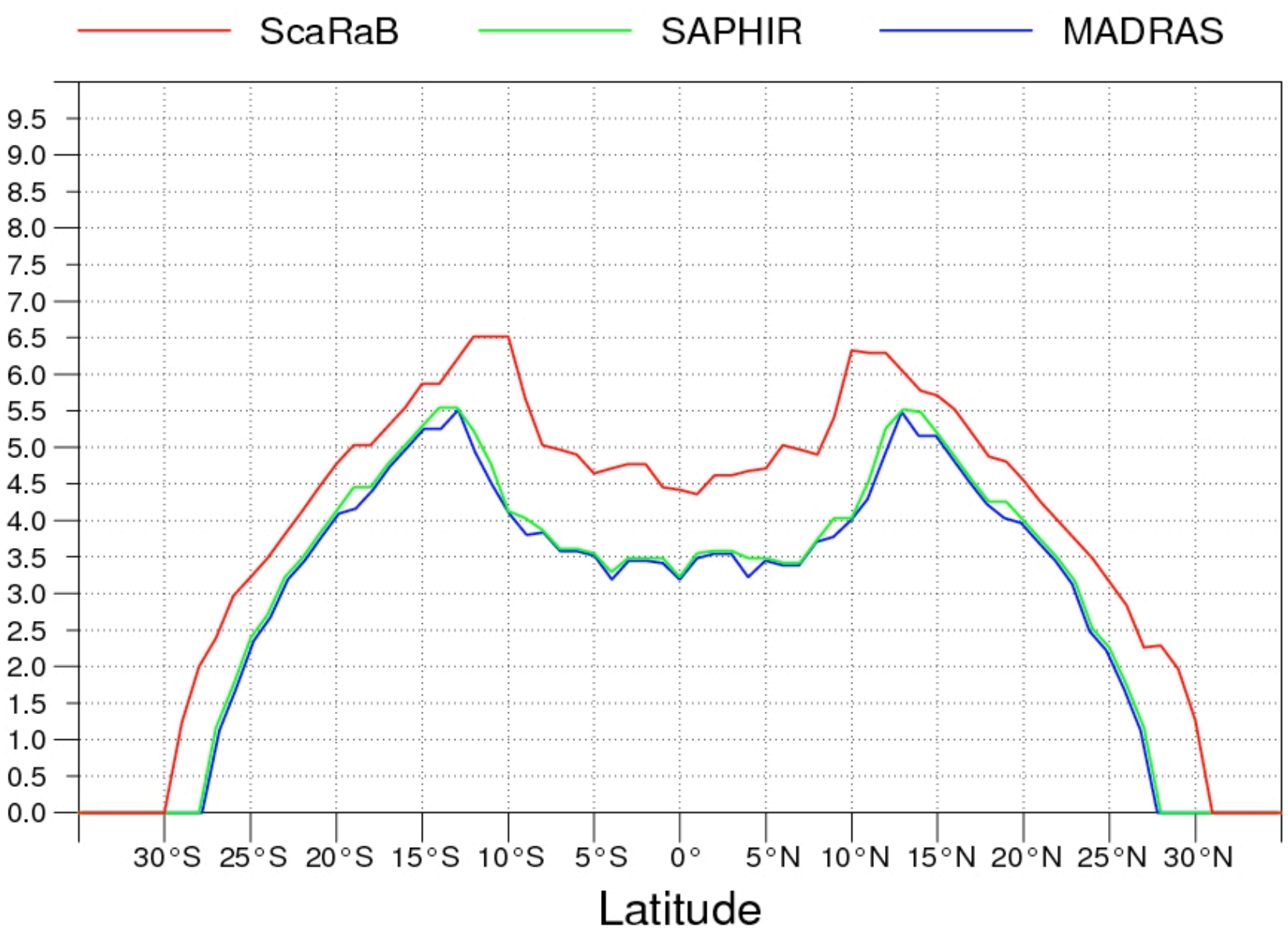
Max. attained latit. = 30.0 °

Ιξιων

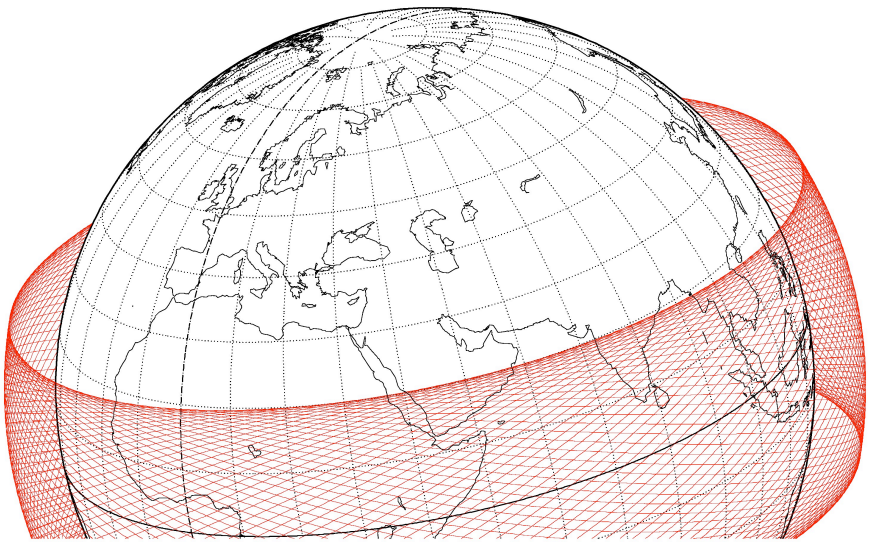
MC ★ LMD

Ατλας

Mean number of overpasses



Comparison with the Sun-Synchronous satellites



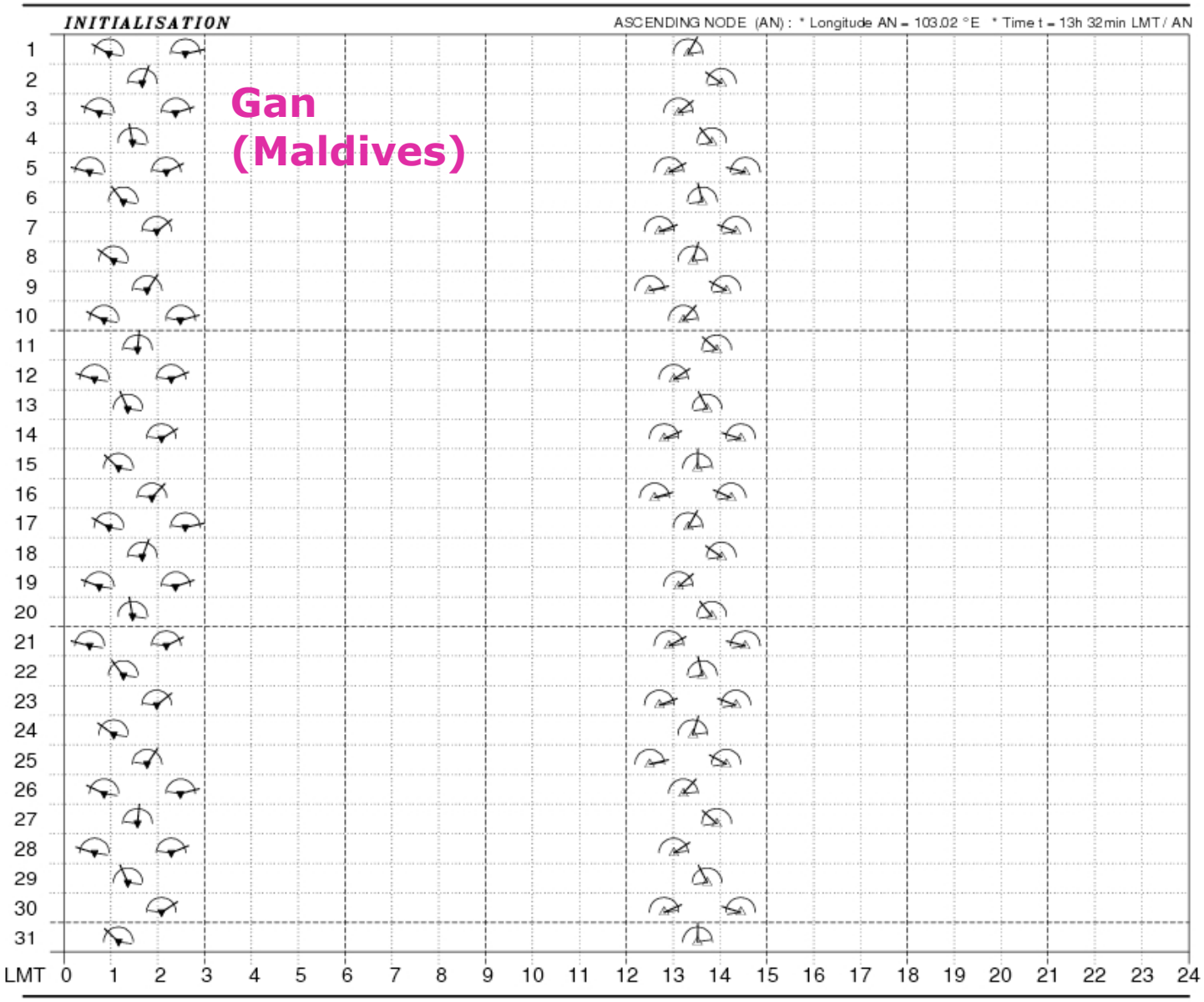
3

Recurrence cycle = 16 days [15; -7; 16] 233
Precession cycle: infinity (SUN-S.)
***

Aqua / CERES

0 °

MONTHLY TABLE



OVERPASSES (n = 81)
OF SATELLITE S [EGM96]
FOR POINT P
- Latitude : 0.0 °
- Longitude : 75.0 ° E
For P: UTC = LMT - 05h 00m

FIELD OF VIEW : 123.6 °

(1) (2) P-S DIRECTION
△ ASC ▼ DES

Right-handed system

- Zenith angle (in the plane orthogonal to the track). (1)
- Azimuth (in the local horizontal plane) (2) with respect to the North.

ORBIT a = 7077.736 km
Altitude = 699.6 km
Incl. / Sun-s.= 98.21 °
Equatorial shift= 2751.9 km
Period = 98.88 min
Mean mot. = 14.56 rev/day

SCANNING
Half-swath = 61.8 °
Maximal zenith angle = 78.0 °
H.-swath (ground) = 1801.2 km
Equatorial overlap = 1.336
Max. attained latit. = 90.0 °
Latit. overlap:82.0 ° <--> 90.0 °

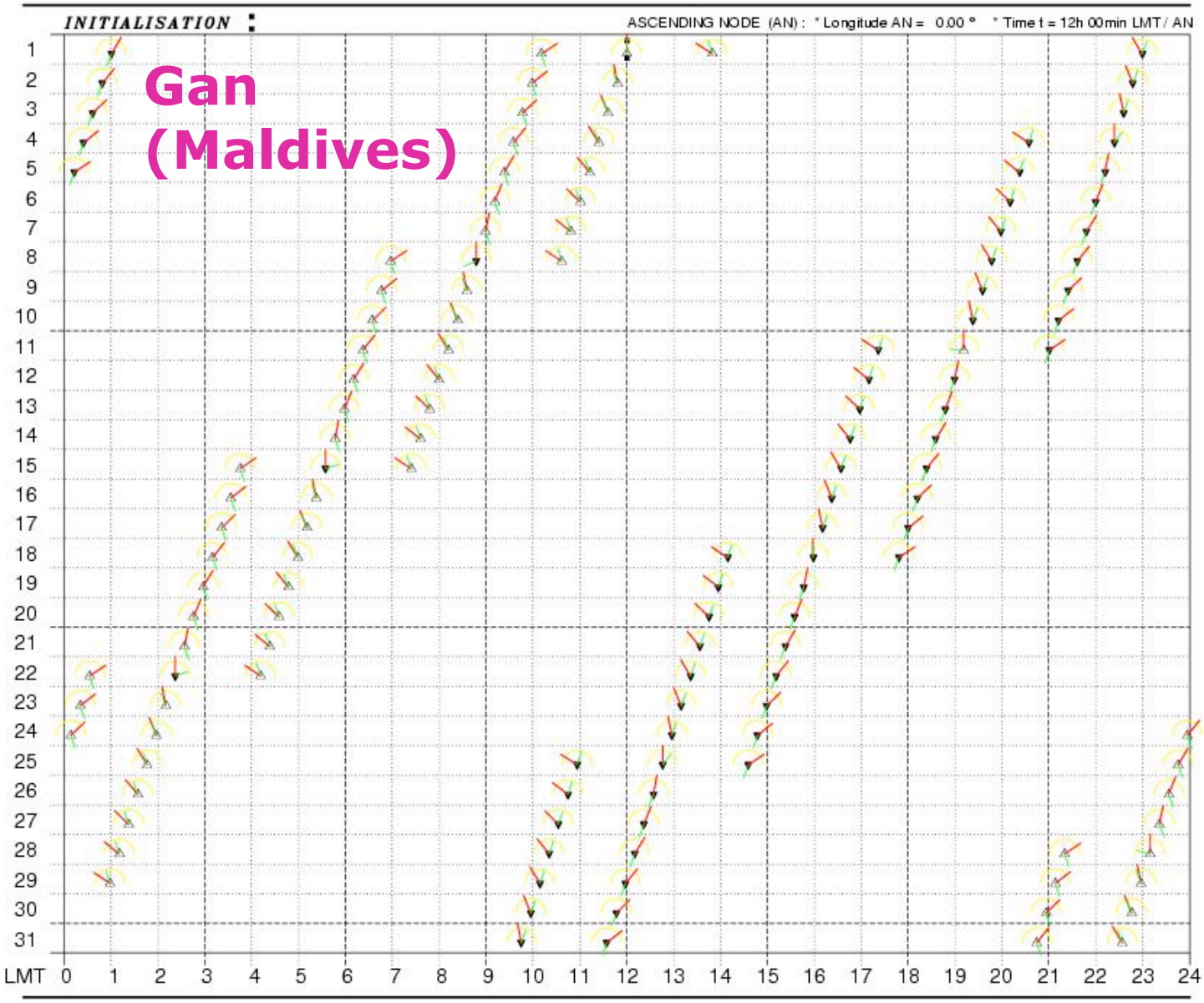
Ιξιων
MC ★ LMD

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
***

Megha-Trop. / ScaRaB

0 °

MONTHLY TABLE



OVERPASSES (n = 136)
OF SATELLITE S [GEM-T2]
FOR POINT P
- Latitude : 0.0 °
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

FIELD OF VIEW : 97.8 °

(1) (2) P-S DIRECTION
△ ASC ▼ DES

Right-handed system

- Zenith angle (in the plane orthogonal to the track). (1)

- Azimuth (in the local horizontal plane) (2) with respect to the North.

ORBIT a = 7243.700 km
Altitude = 865.6 km
Inclination = 20.00 °
Equatorial shift= 2892.0 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

SCANNING
Half-swath = 48.9 °
Maximal zenith angle = 58.9 °
H.-swath (ground) = 1108.3 km
Equatorial overlap = 2.089
Max. attained latit. = 30.0 °

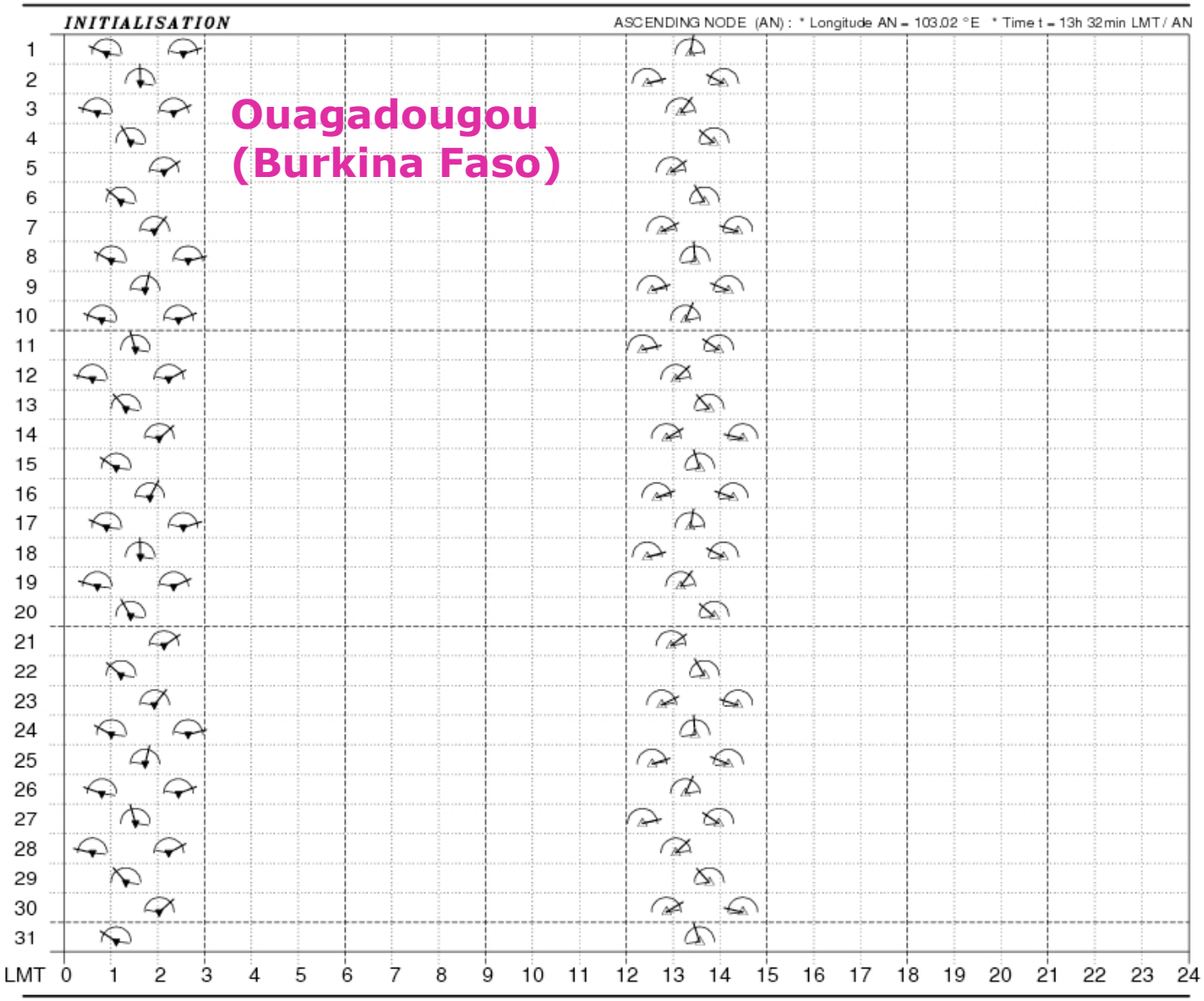
Ξιων
MC ★ LMD

Recurrence cycle = 16 days [15; -7; 16] 233
Precession cycle: infinity (SUN-S.)
***

Aqua / CERES

10 ° N

MONTHLY TABLE



OVERPASSES (n = 83)
OF SATELLITE S [EGM96]
FOR POINT P
- Latitude : 10.0 ° N
- Longitude : 75.0 ° E
For P: UTC = LMT - 05h 00m

FIELD OF VIEW : 123.6 °

(1) (2) P-S DIRECTION
△ ASC ▼ DES

Right-handed system

- Zenith angle (in the plane orthogonal to the track). (1)
- Azimuth (in the local horizontal plane) with respect to the North. (2)

ORBIT a = 7077.736 km
Altitude = 699.6 km
Incl. / Sun-s.= 98.21 °
Equatorial shift= 2751.9 km
Period = 98.88 min
Mean mot. = 14.56 rev/day

SCANNING
Half-swath = 61.8 °
Maximal zenith angle = 78.0 °
H.-swath (ground) = 1801.2 km
Equatorial overlap = 1.336
Max. attained latit. = 90.0 °
Latit. overlap:82.0 ° <--> 90.0 °

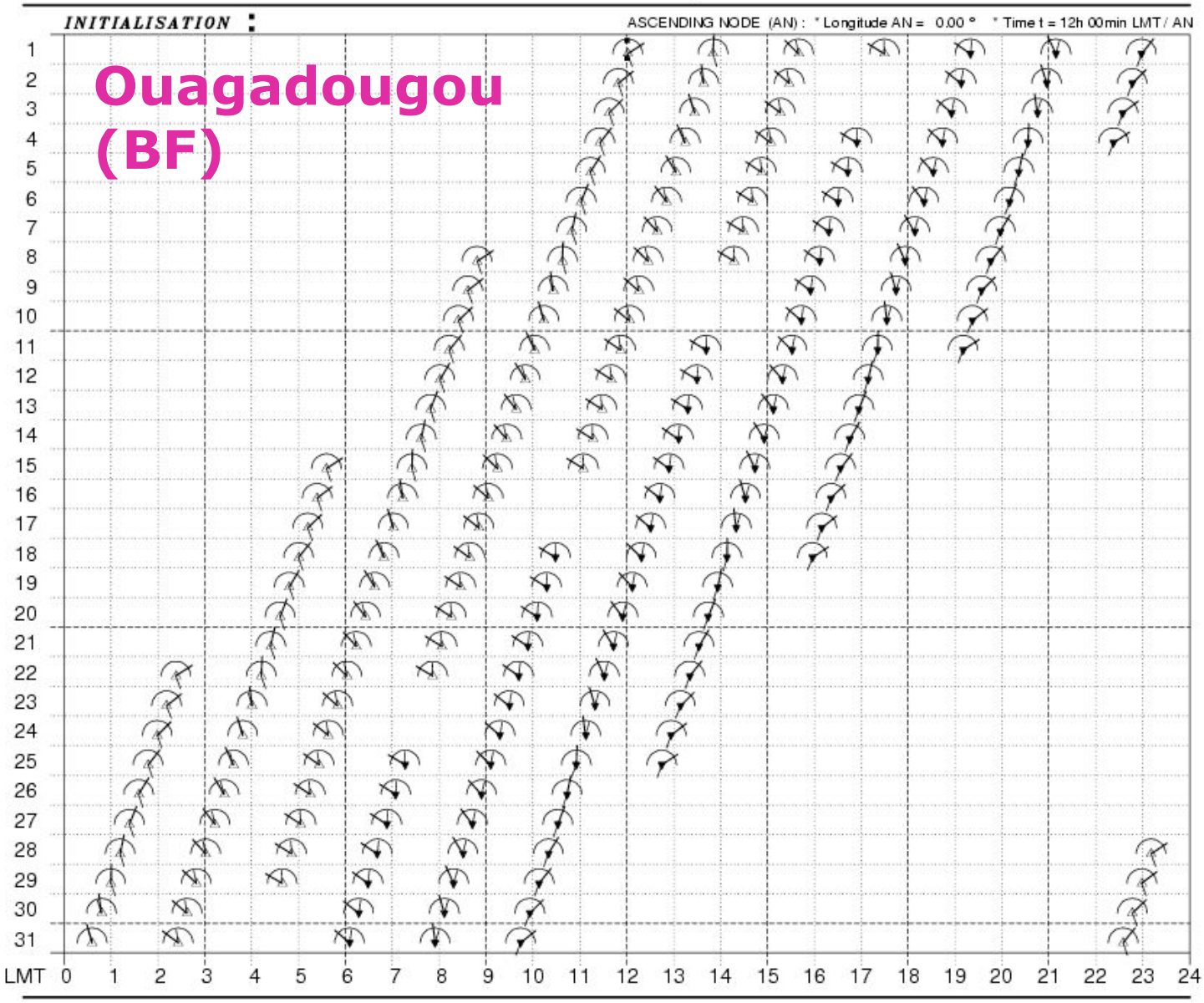
Ξιων
MC ★ LMD

Recurrence cycle = 7 days [14; -1; 7] 97
Precession cycle= 51 days (Cs= -51.3)
***

Megha-Trop. / ScaRaB

10 ° N

MONTHLY TABLE



OVERPASSES (n = 196)
OF SATELLITE S [GEM-T2]
FOR POINT P
- Latitude : 10.0 ° N
- Longitude : 0.0 °
For P: UTC = LMT + 00h 00m

FIELD OF VIEW : 97.8 °

(1) (2) P-S DIRECTION
△ ASC ▼ DES

Right-handed system

- Zenith angle (in the plane orthogonal to the track). (1)

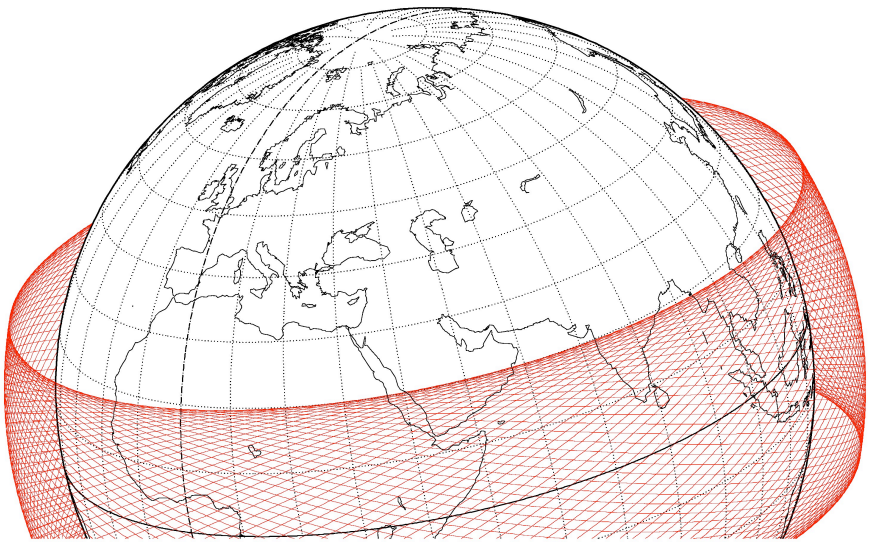
- Azimuth (in the local horizontal plane) (2) with respect to the North.

ORBIT a = 7243.700 km
Altitude = 865.6 km
Inclination = 20.00 °
Equatorial shift= 2892.0 km
Period = 101.93 min
Mean mot. = 14.13 rev/day

SCANNING
Half-swath = 48.9 °
Maximal zenith angle = 58.9 °
H.-swath (ground) = 1108.3 km
Equatorial overlap = 2.089
Max. attained latit. = 30.0 °

Ξιων
MC ★ LMD

Overlapping MT and Terra

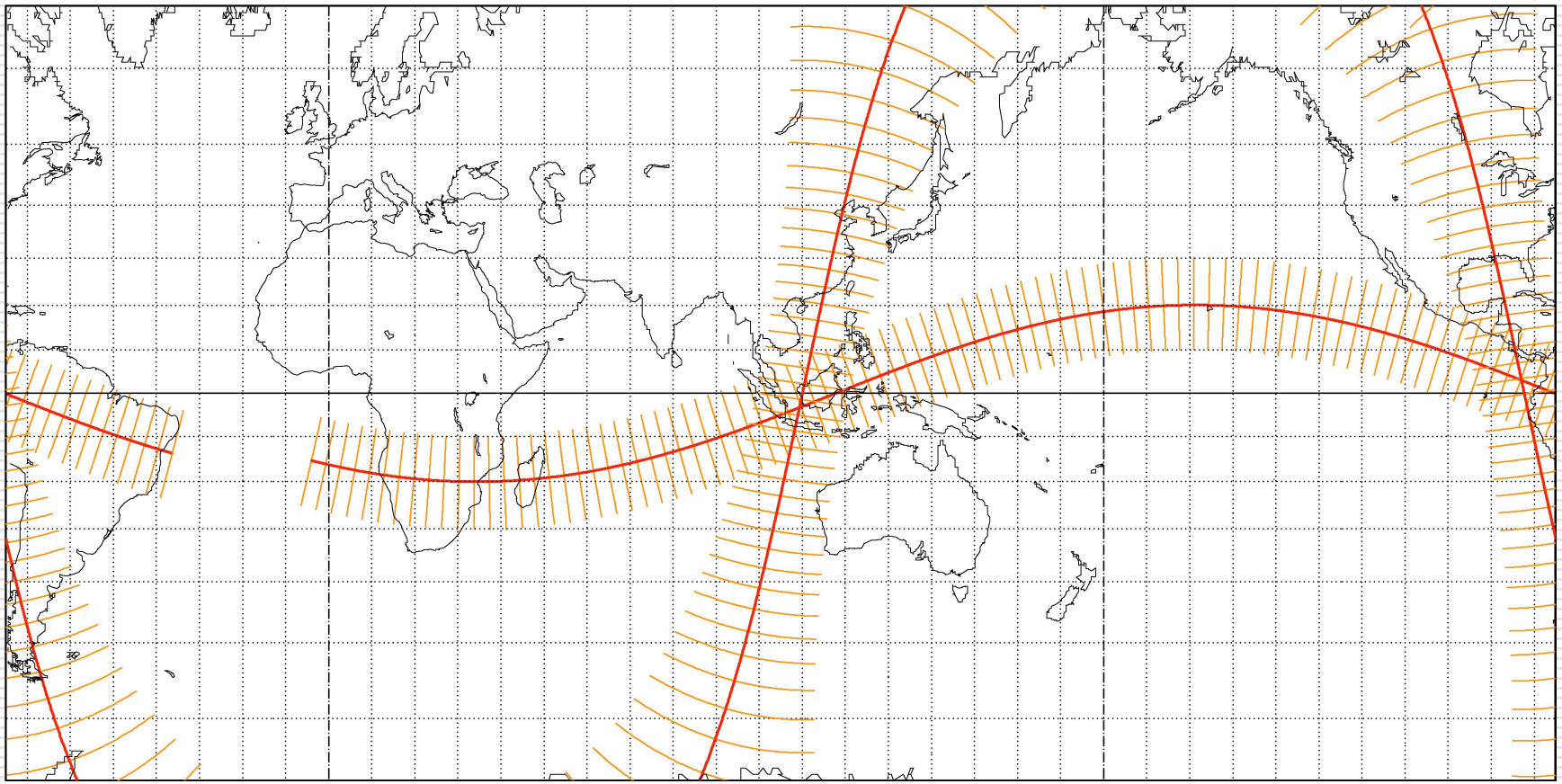


4

Megha-Tropiques / ScaRaB and Terra / CERES

In-space and in-time **Rendez-vous**

- Example: April 17, 2012. 03:10 UTC



Megha-Tropiques

0 km <-> 1760 km - Locations of overlapping with Terra
[+/- 4.0 min]

Recurrence = [14; -1; 7] 97

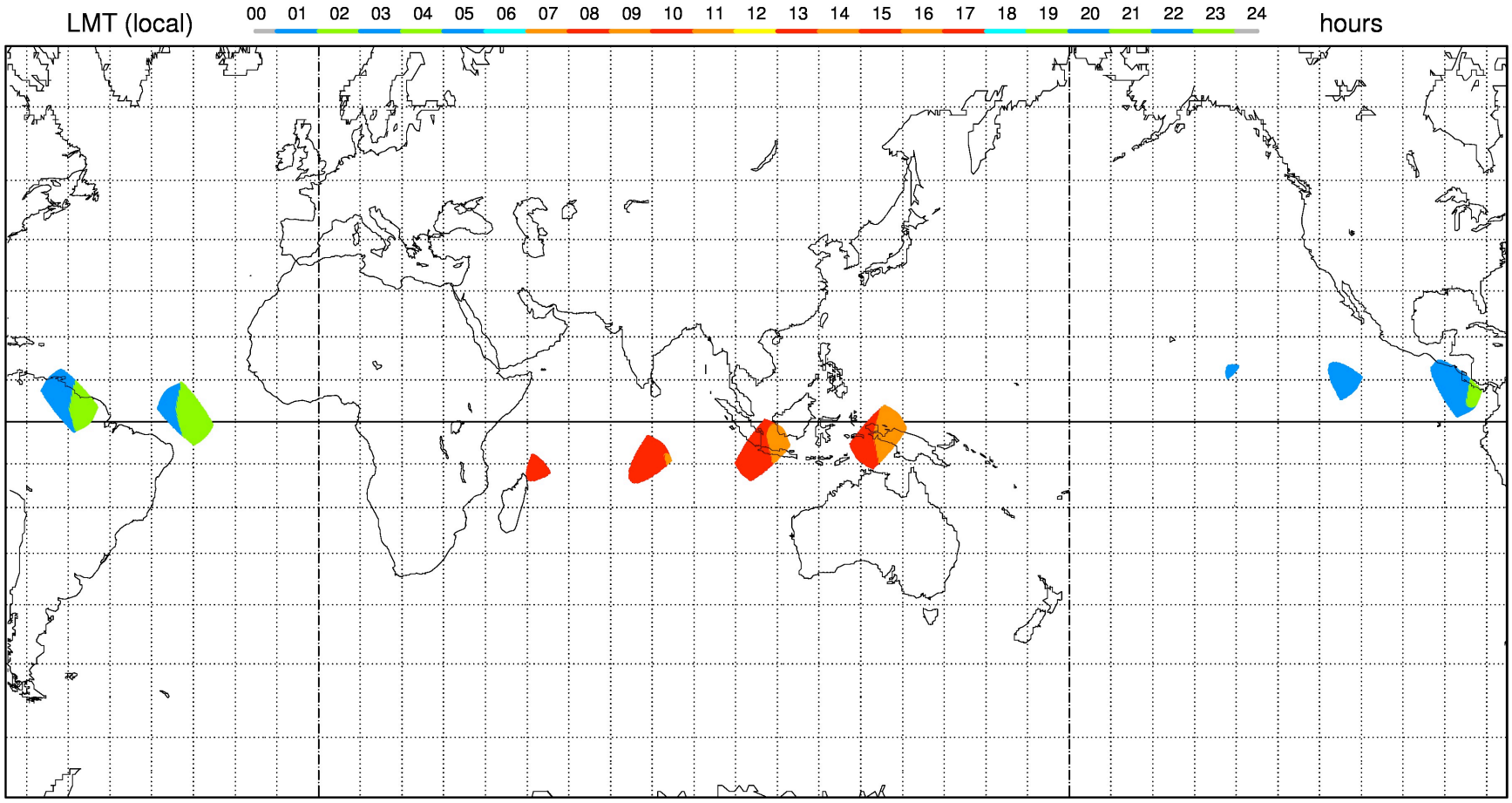
2012 04 17 00:00:00 UTC >>> 1440.0 min = 1.00 day

Altitude = 865.5 km a = 7243.599 km

Inclination = 19.98 ° e = 0.001019

Period = 101.93 min * rev/day =14.13

*** [+/- 1108 km] Megha-Trop *** [+/- 1165 km] Terra

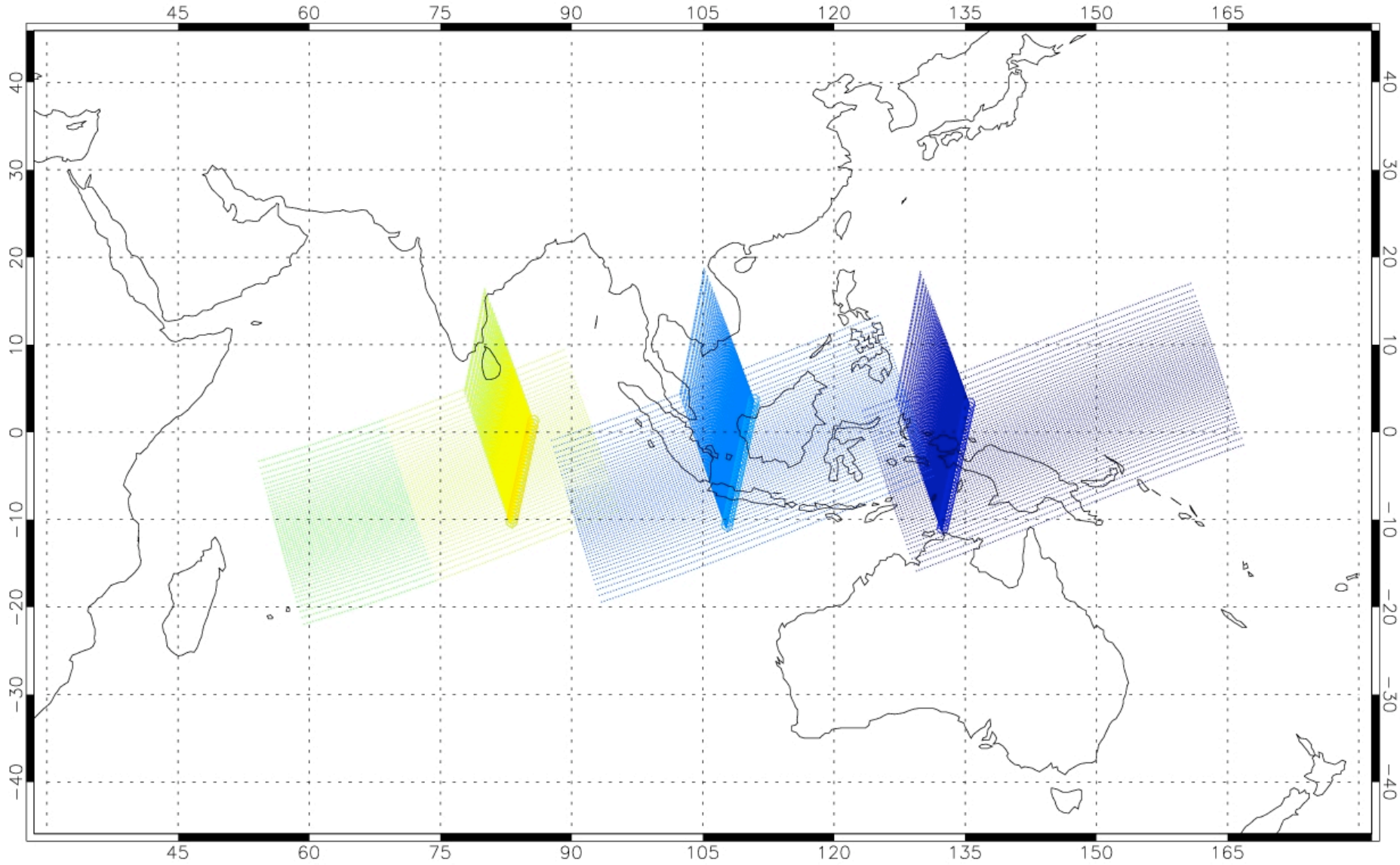


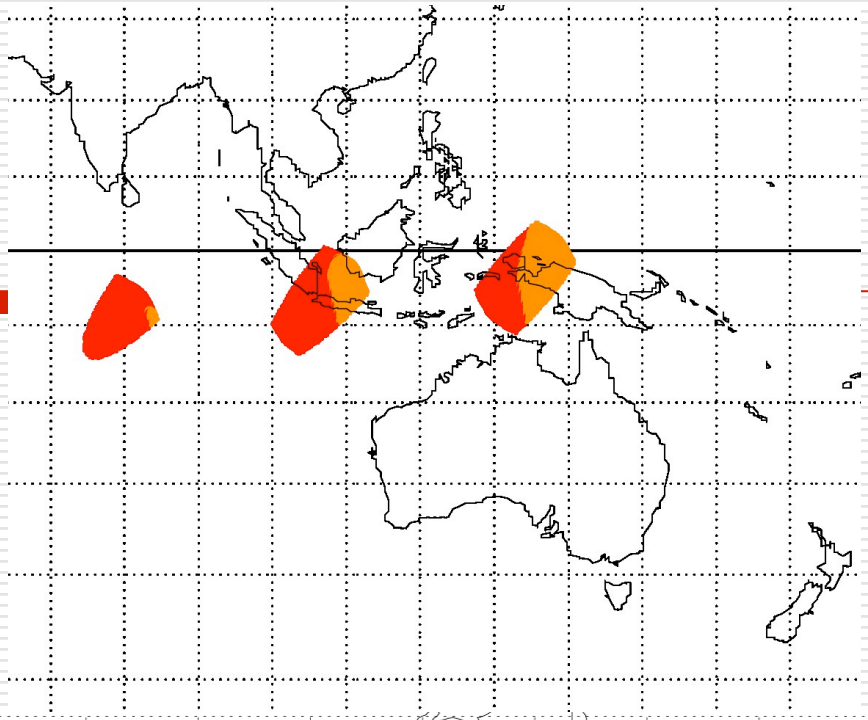
Projection: Mercator
Property: Conformal
⊕ T.:Cylindrical - Graticule: 10°

Project. centre: 0.0 ° ; 105.0 °E
Aspect: Direct
{4.2}[+90.0/ +0.0/+165.0] [-] EIGEN-C3

Asc. Node: 162.23 ° [13:29 LMT]
[NORAD] Revolution: 2581
[NORAD] 2012 04 12 02:39:35 UTC

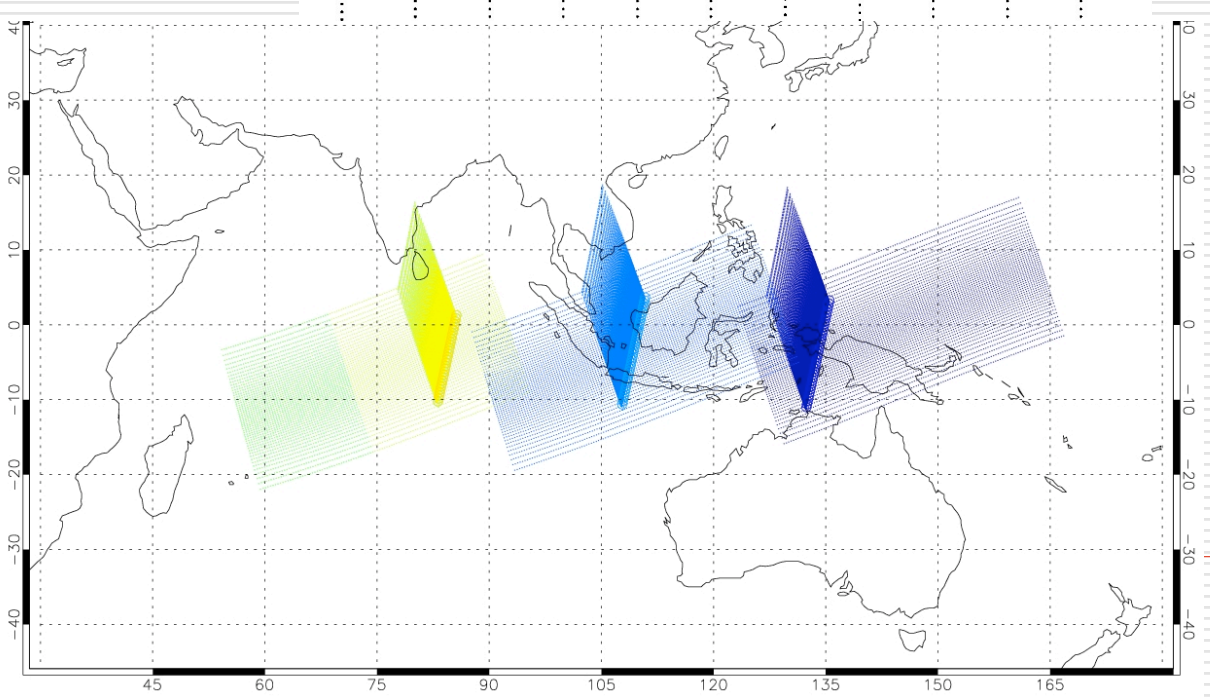
Ιξιων
MC ★ LMD
Ατλας


45
60
75
90
105
120
135
150
165
40
30
20
10
0
−10
−20
−30
−40



Prediction by Ixion.

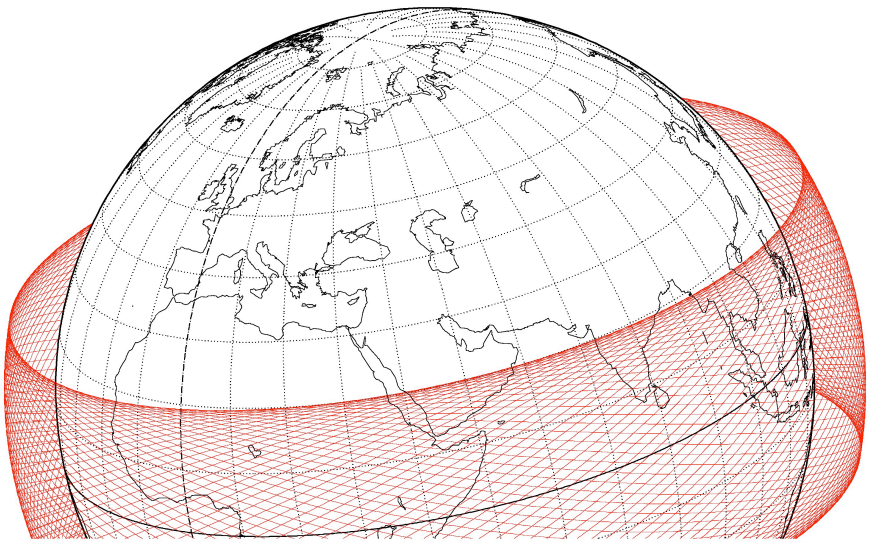
Norad (Two-Line Elements)
5 days in advance.



Results

with pixel coordinates
provided by
space agencies.

Occurrence of Sun glint



5

Aqua / MODIS

Trace de l'orbite - Réfl. Spéc. [Cone D.-ouv.: 8.0°]

2010 07 11 21:00:00 TUC >>> 1440.0 min = 1.00 jour

Trace des fauchées orthogonales (mode XT)

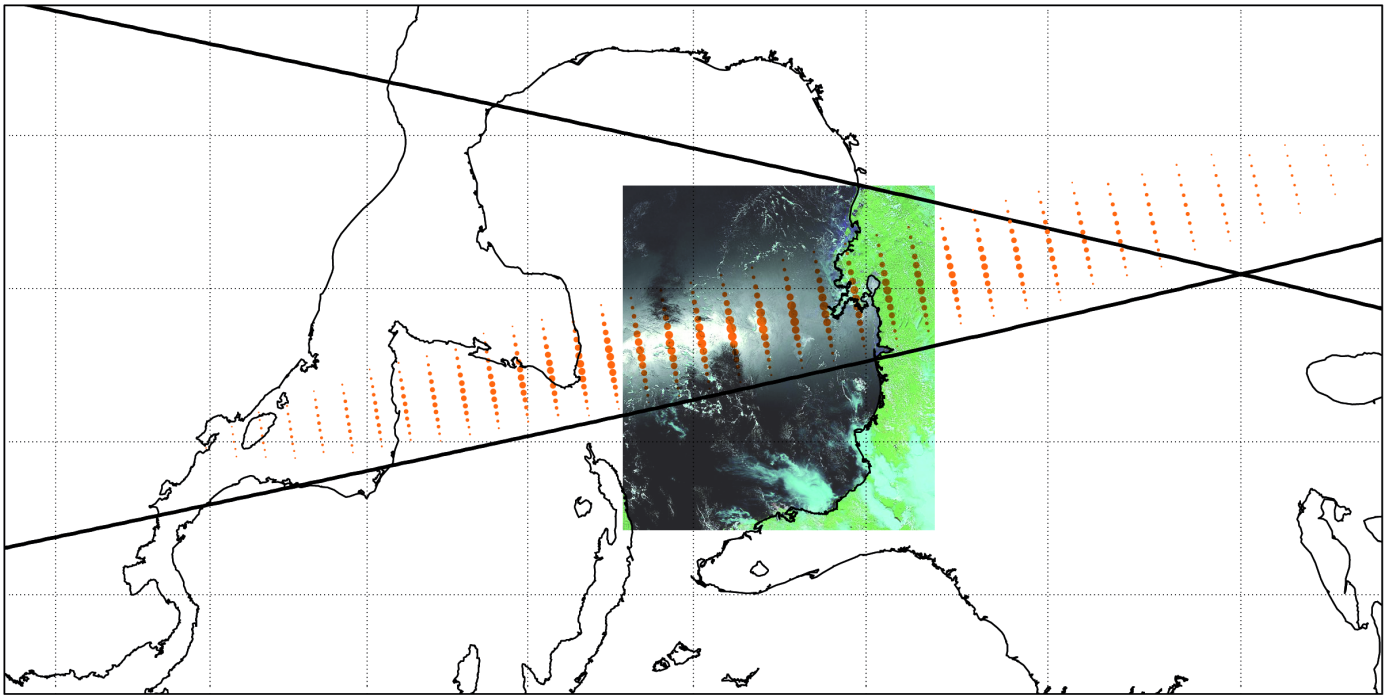
Altitude = 699.5 km a = 7077.668 km

Incl. HELIOS. = 98.19 ° e = 0.000188

Période = 98.88 min * Révol./j.=14.56

** Demi-fauchée : 55.2° [2.0] - Au sol : 1165.0 km [0.50 min]

Hauteur Soleil (°) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 **12 JUL**



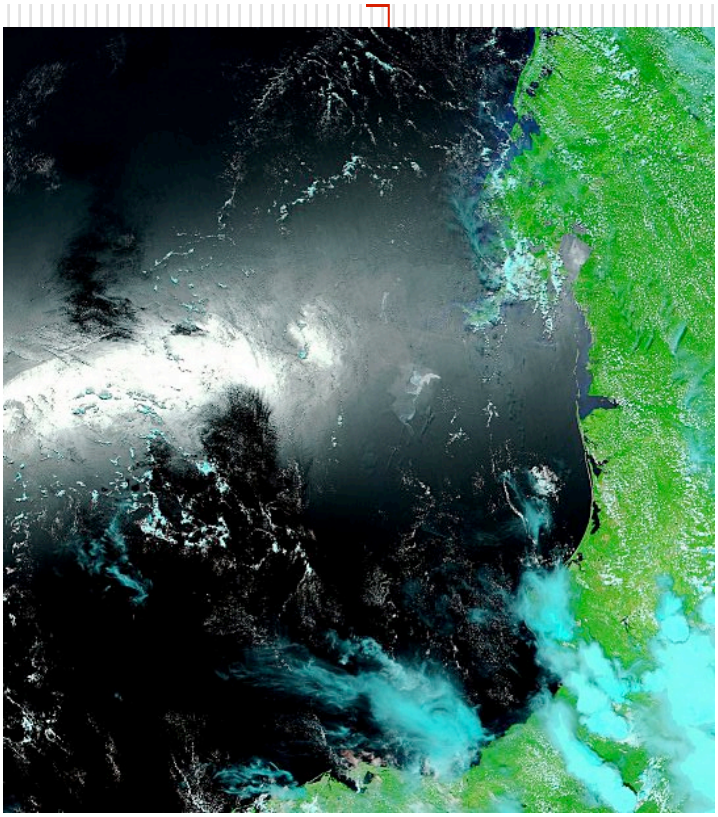
Projection : Mercator
Propriété : Conforme
⊕ T.: Cylindrique - Grille : 5°

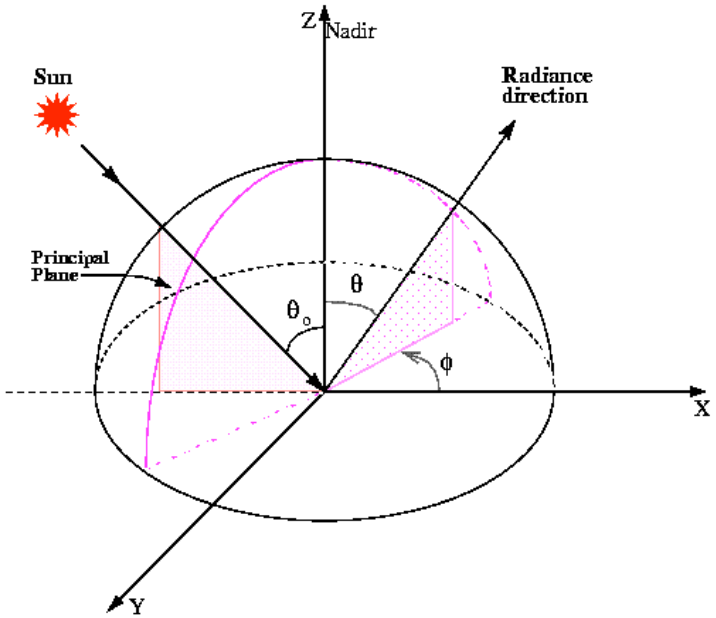
CP: 0.0 ° ; 0.0 ° /CZ: 25.0 ° N; 88.0 ° W
Aspect : Direct **> zoom : 8.00**
{5.3} [+90.0/ +0.0/ -90.0] [-90] EGM96

Noeud asc : 127.76 ° [13:36 TSM]
[NORAD] Révolution : 43541
[NORAD] 2010 07 11 05:05:24 TUC

Ιξιων
MC ★ LMD
Ατλας

July 12, 2010
NASA/GSFC, MODIS
Rapid Response
Deepwater Horizon
BP platform





θ_o: Solar zenith angle.

θ: Zenith angle of the radiance. Range: 0-180.; 0 for straight-up; 90 for horizon; and 180 for straight-down.

ϕ: Relative azimuth angle of radiance. Range: 0-360.; 0 as forward scattering; 180 as back scattering.

Sun glint conditions

SZA : Solar Zenith Angle
VZA : Viewing Zenith Angle
RA : relative Azimuth

Variation range:
VZA between (VZA - *a*) and (VZA + *a*)
RA between (RA - *a*) and (RA + *a*)

In a cone with a half-aperture of *a* degrees

Mirror	…….	*a*=0°16’
Calm sea	…….	*a*=10°
Rough sea	…….	*a*=20°

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 102.0 min = 0.07 day

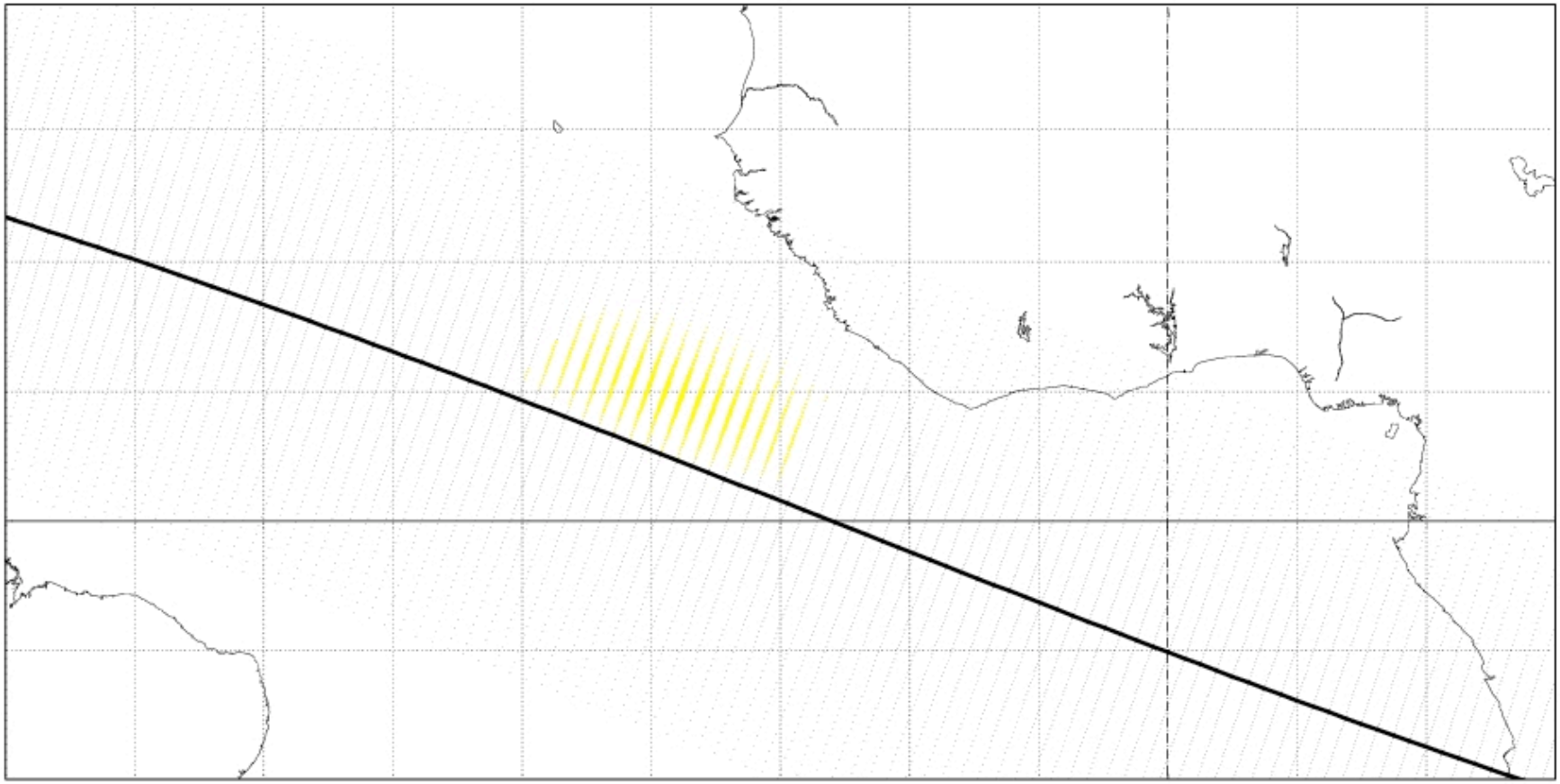
Period = 101.93 min * rev/day =14.13

Across track swath (XT mode)

** Half-swath: 49.0° [1.0] - On ground 1112.7 km [0.20 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 JUN



Projection: Mercator

Property: Conformal

⊕ T.:Cylindrical - Graticule: 5°

PC: 0.0 ° ; 0.0 ° /ZC: 5.0 ° N; 15.0 ° W

Aspect: Direct **> zoom : 6.00**

{5.3} [+90.0/ +0.0/ -90.0] [-] GEM-T2

Asc. node: -180.00 ° [00:00 LMT]

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 20 / Azi: 20]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 102.0 min = 0.07 day

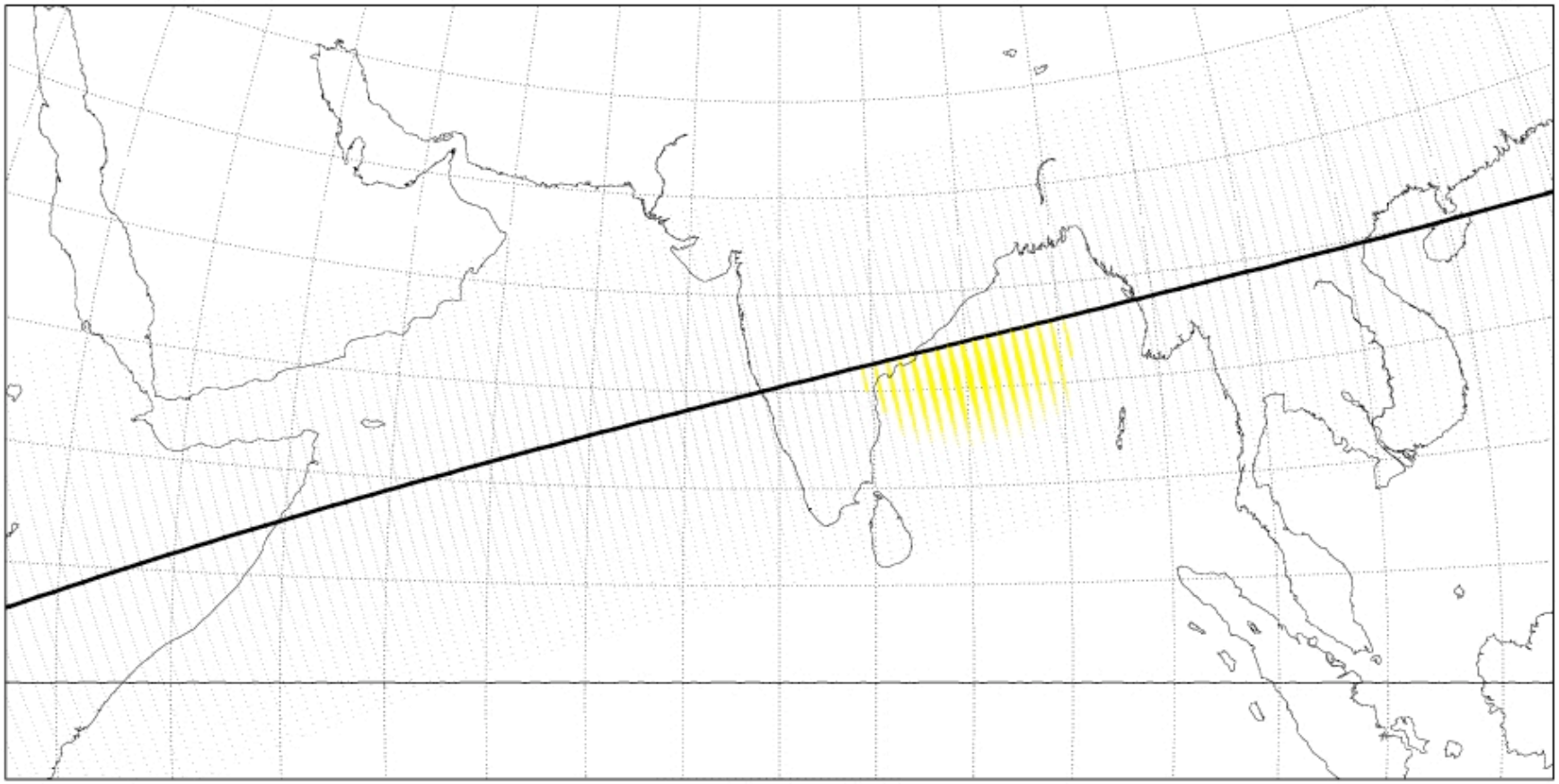
Period = 101.93 min * rev/day =14.13

Across track swath (XT mode)

** Half-swath: 48.9° [1.0] - On ground 1108.2 km [0.20 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator

Property: Conformal

⊕ T.:Cylindrical - Graticule: 5°

PC: 0.0 ° ; 75.0 °E /ZC: 15.0 ° N; 75.0 ° E

Aspect: Transverse **> zoom : 4.50**

{5.3}[+0.0/ +90.0/ -75.0] [-90] GEM-T2

Asc. node: 30.00 ° [08:00 LMT]

Ιξιων

MC ★ LMD

Ατλας

ADEOS-2 〈 みどり 〉

Orbit - Ground track - Sunglint [Zen: 12 / Azi: 12]

Altitude = 802.9 km a = 7181.057 km

Inclination / SUN-SYNCHRON.= 98.64 °

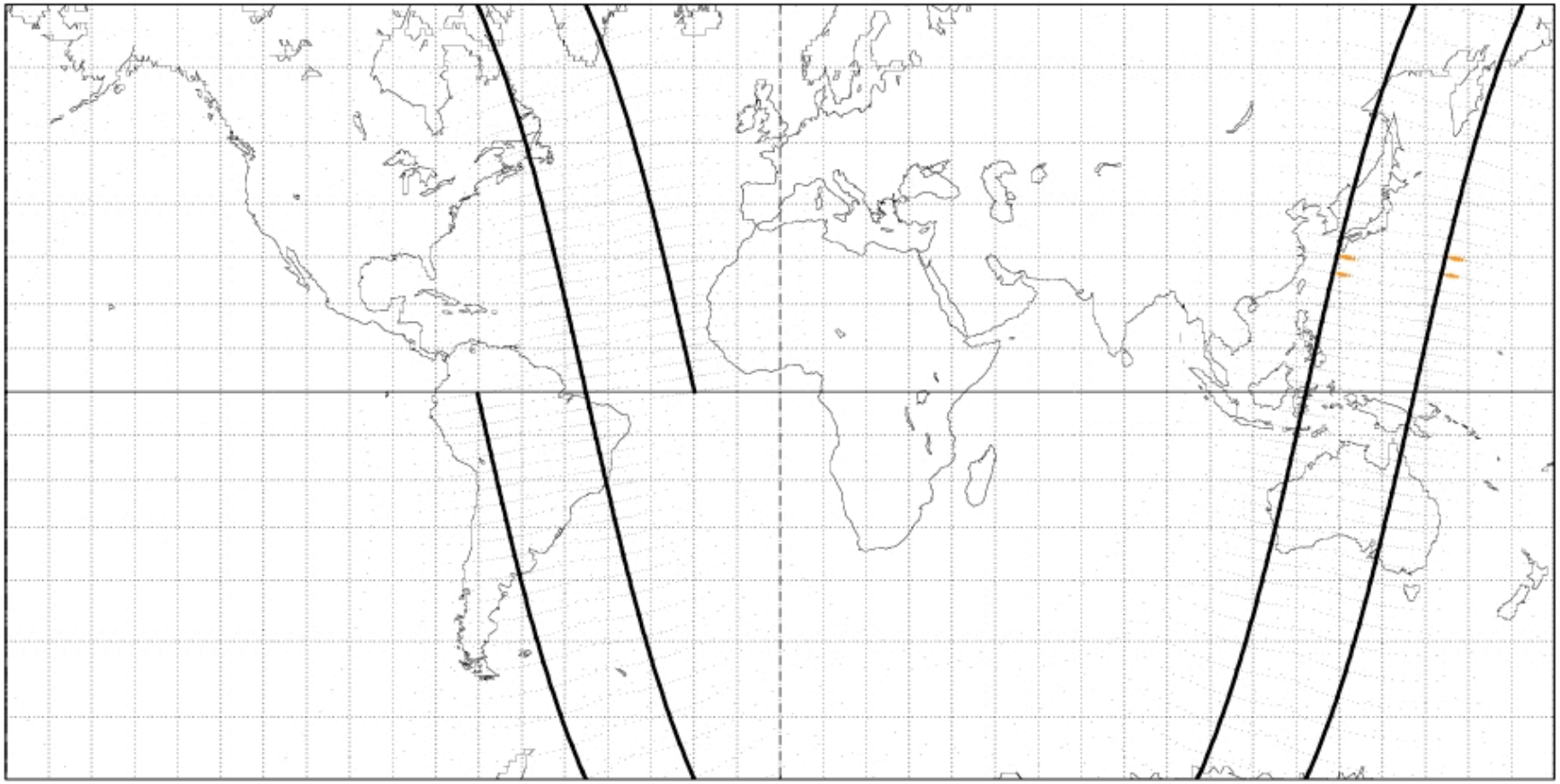
>>>> Time span shown: 202.0 min = 0.14 day

Period = 101.05 min * rev/day =14.25

Across track swath (XT mode)

** Half-swath: 62.6° [5.0] - On ground 3045.0 km [1.00 min]

LMT (local) 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 hours 21 JUN



Projection: Mercator

Property: Conformal

⊕ T.:Cylindrical - Graticule: 10°

Project. centre: 0.0 ° ; 0.0 °

Aspect: Direct

{4.2}[+0.0/ +0.0/ +0.0] [-] GEM-T2

Asc. node: -19.86 ° [22:20 LMT]

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 102.0 min = 0.07 day

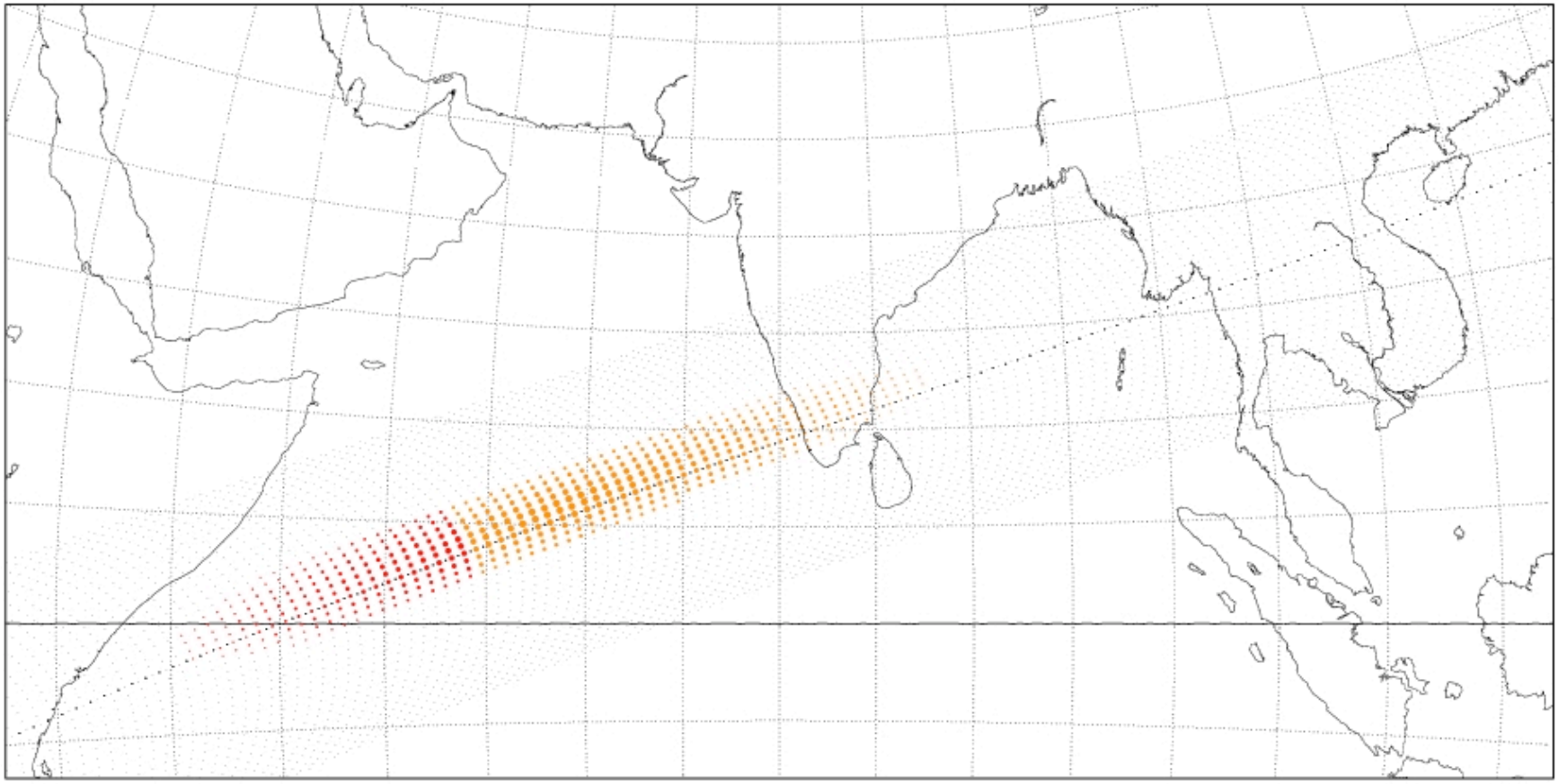
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.20 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 JUN



Projection: Mercator PC: 0.0 ° ; 75.0 °E /ZC: 12.0 ° N; 75.0 ° E Asc. node: 50.00 ° [08:00 LMT]

Property: Conformal Aspect: Transverse **> zoom : 4.50**

⊕ T.:Cylindrical - Graticule: 5° {5.3}[+0.0/ +90.0/ -75.0] [-90] GEM-T2

Ιξιων

MC ⋆ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 20 / Azi: 20]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 102.0 min = 0.07 day

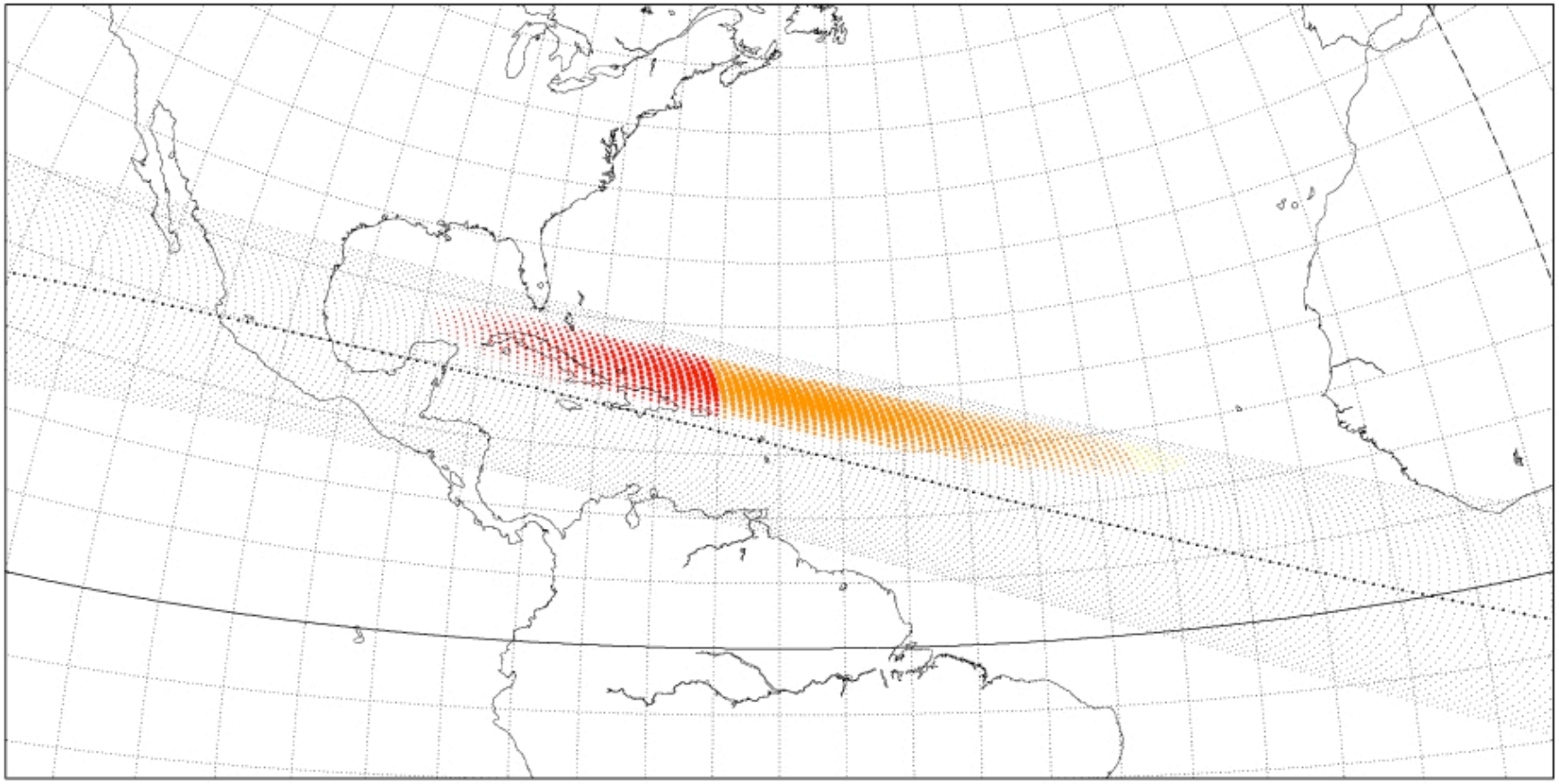
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.20 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 JUN



Projection: Guyou

Property: Conformal

⊕ T.:(various) - Graticule: 5°

Project. centre: 20.0 ° N; 60.0 ° W

Aspect: Transverse **> zoom : 3.50**

{5.3}[+20.0/ +90.0/ +60.0] [-90] GEM-T2

Asc. node: -180.00 ° [00:00 LMT]

Ιξιων

MC ★ LMD

Ατλας

SUN GLINT *Conical swath*

- Sun glint for MADRAS/Megha-Tropiques
- Day: September 21
- MT Equatorial Crossing Time (Ascending Node)
- **LMT** (Local Mean Solar Time):

  00:00
  03:00
  06:00
  09:00
  12:00
  15:00
  18:00
  21:00

00h

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 1440.0 min = 1.00 day

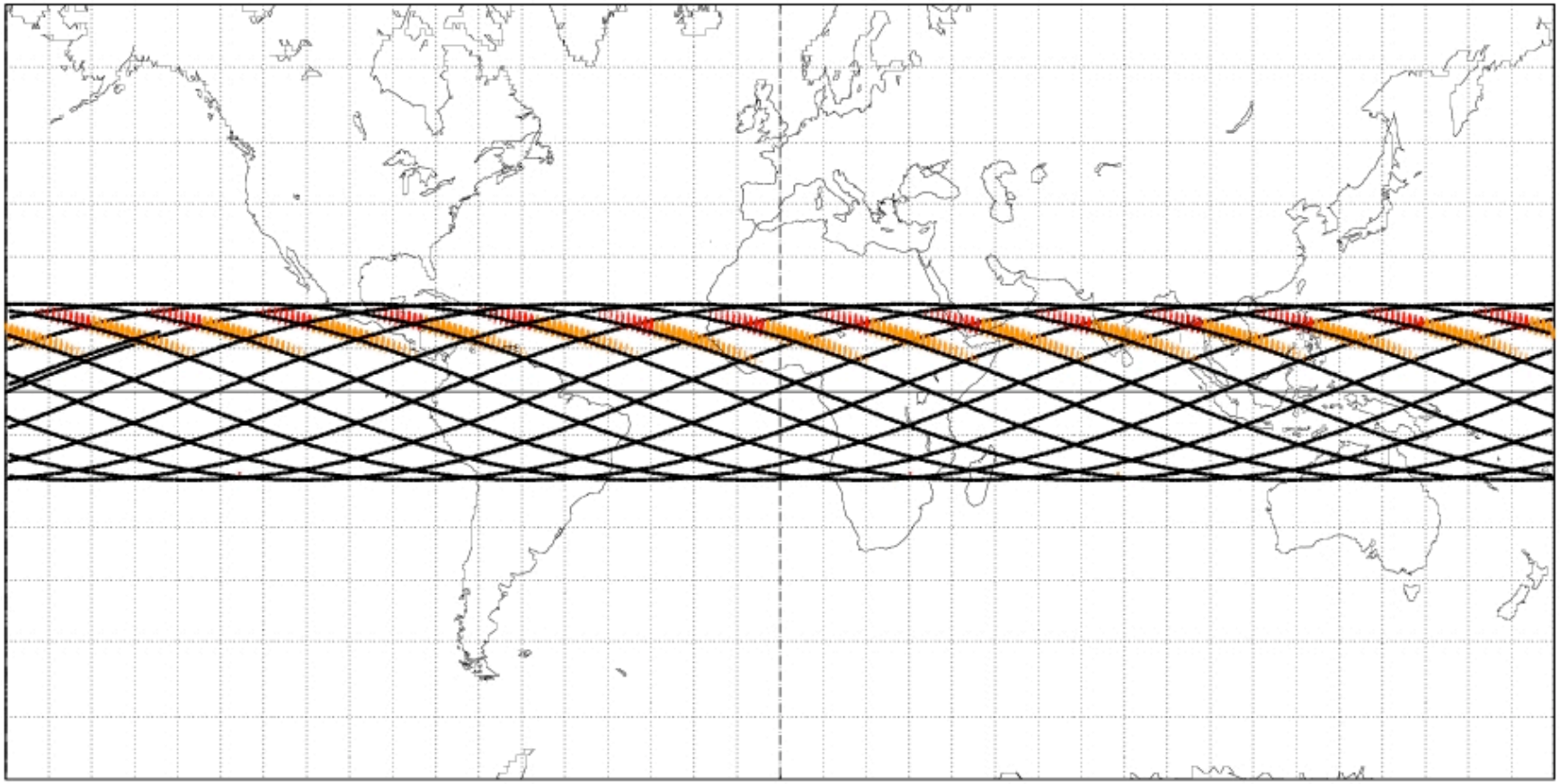
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.50 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: -180.00 ° [00:00 LMT]

Property: Conformal Aspect: Direct

⊕ T.:Cylindrical - Graticule: 10° {4.2}[+0.0/ +0.0/ +0.0] [-] GEM-T2

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 1440.0 min = 1.00 day

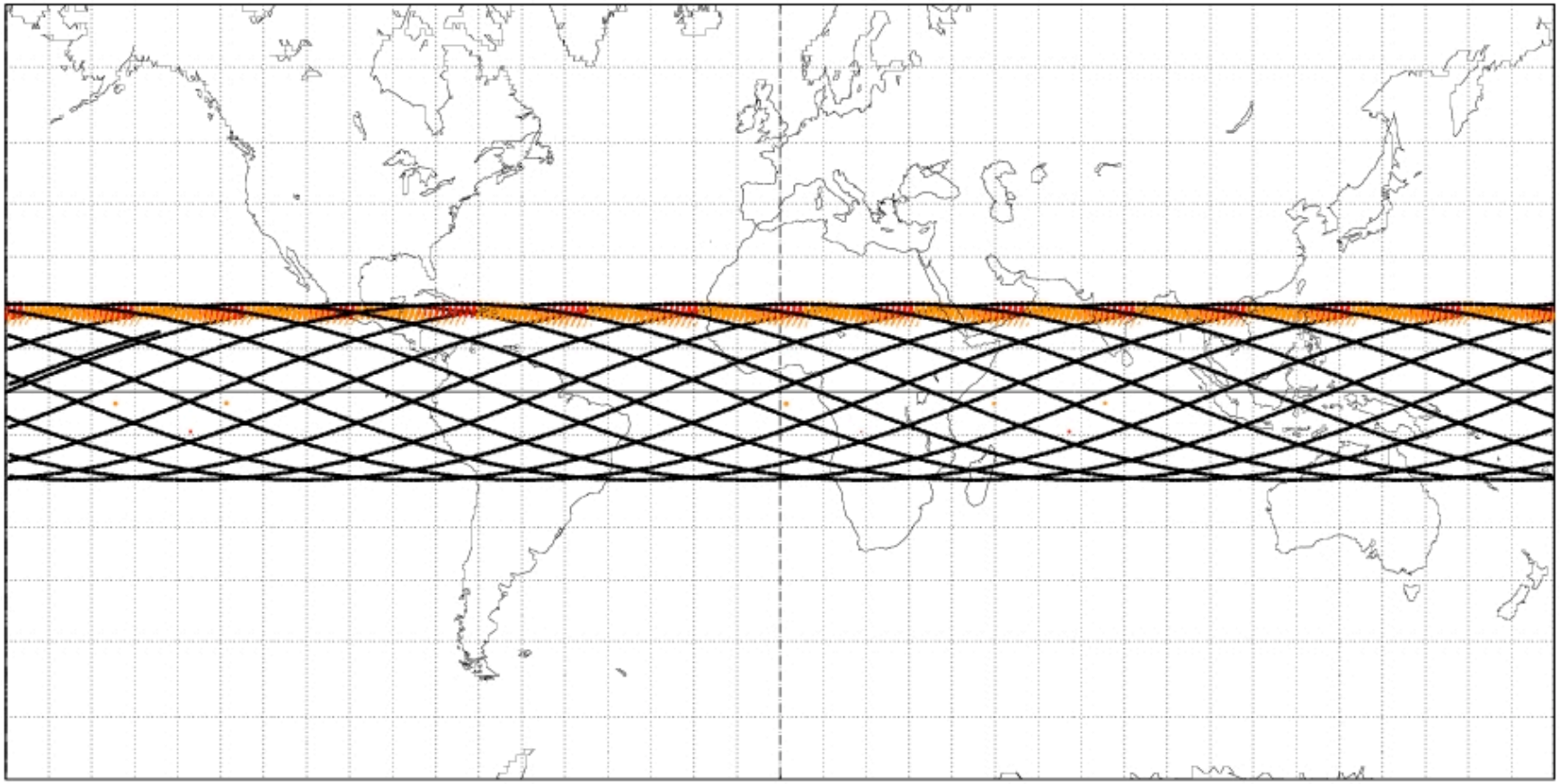
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.50 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: -180.00 ° [03:00 LMT]

Property: Conformal Aspect: Direct

⊕ T.:Cylindrical - Graticule: 10° {4.2} [+90.0/ +0.0/ -90.0] [-] GEM-T2

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 1440.0 min = 1.00 day

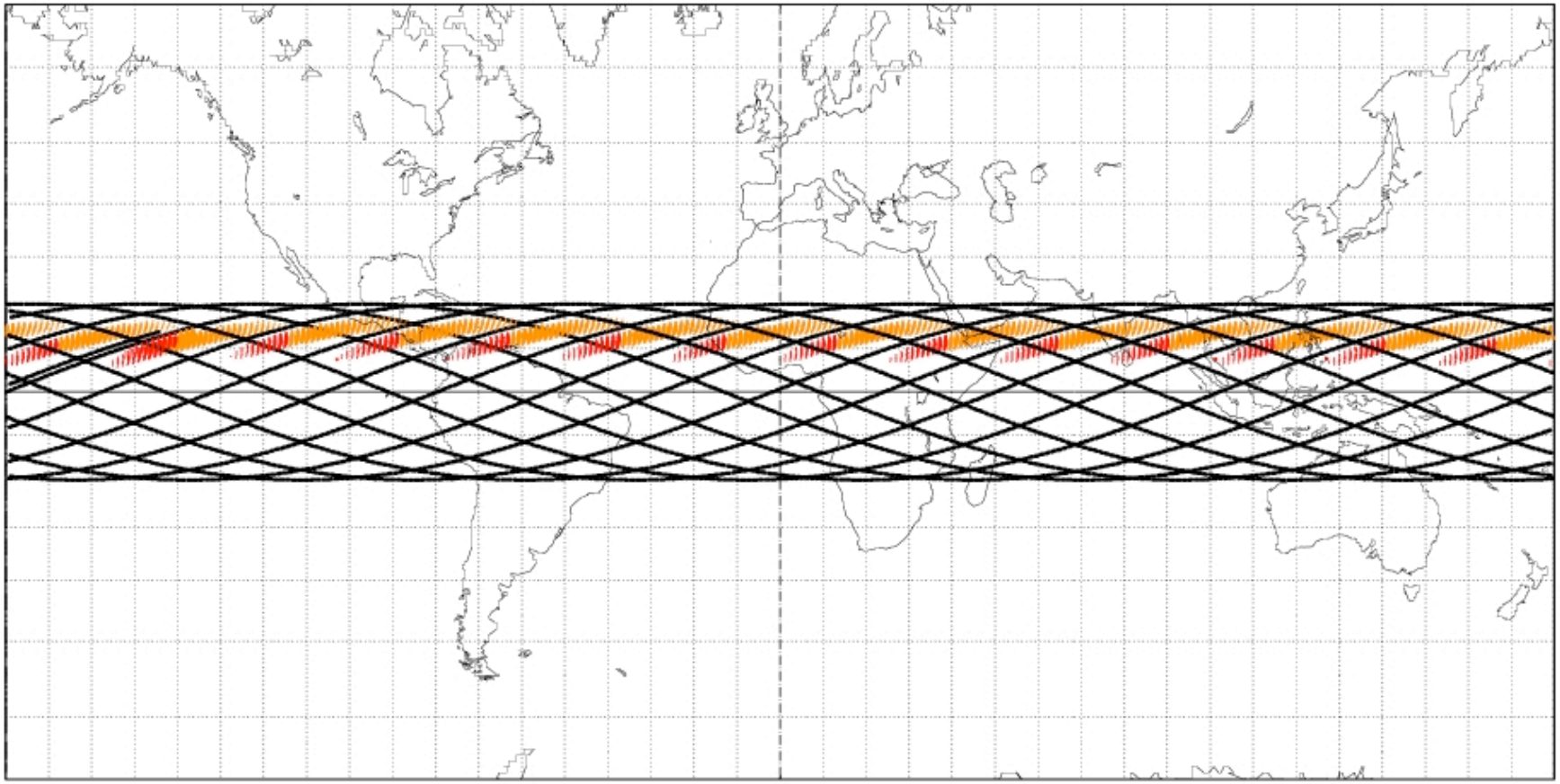
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.50 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: -180.00 ° [06:00 LMT]

Property: Conformal Aspect: Direct

⊕ T.:Cylindrical - Graticule: 10° {4.2} [+90.0/ +0.0/ -90.0] [-] GEM-T2

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 1440.0 min = 1.00 day

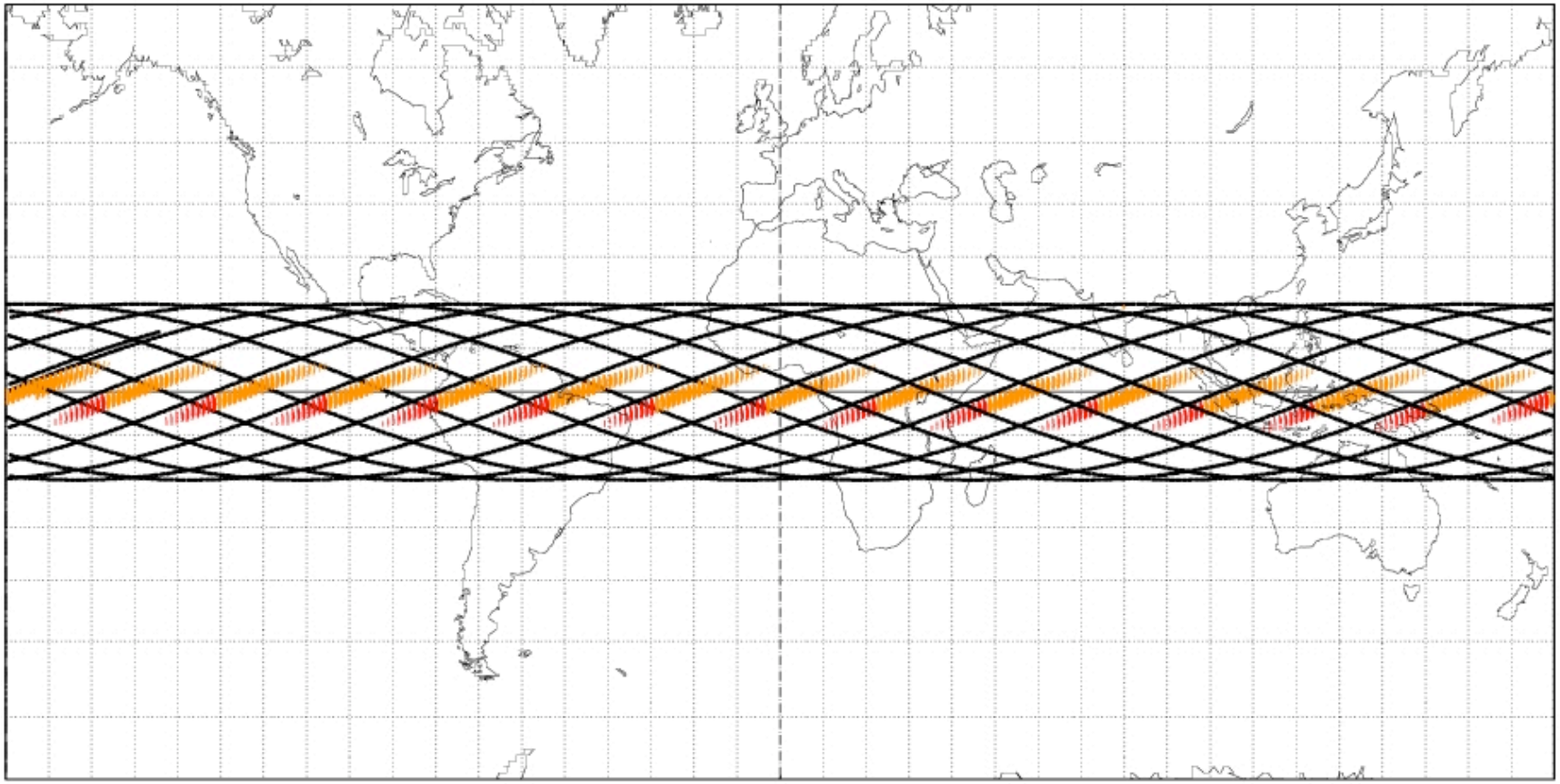
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.50 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: -180.00 ° [09:00 LMT]

Property: Conformal Aspect: Direct

⊕ T.:Cylindrical - Graticule: 10° {4.2}[+0.0/ +0.0/ +0.0] [-] GEM-T2

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 1440.0 min = 1.00 day

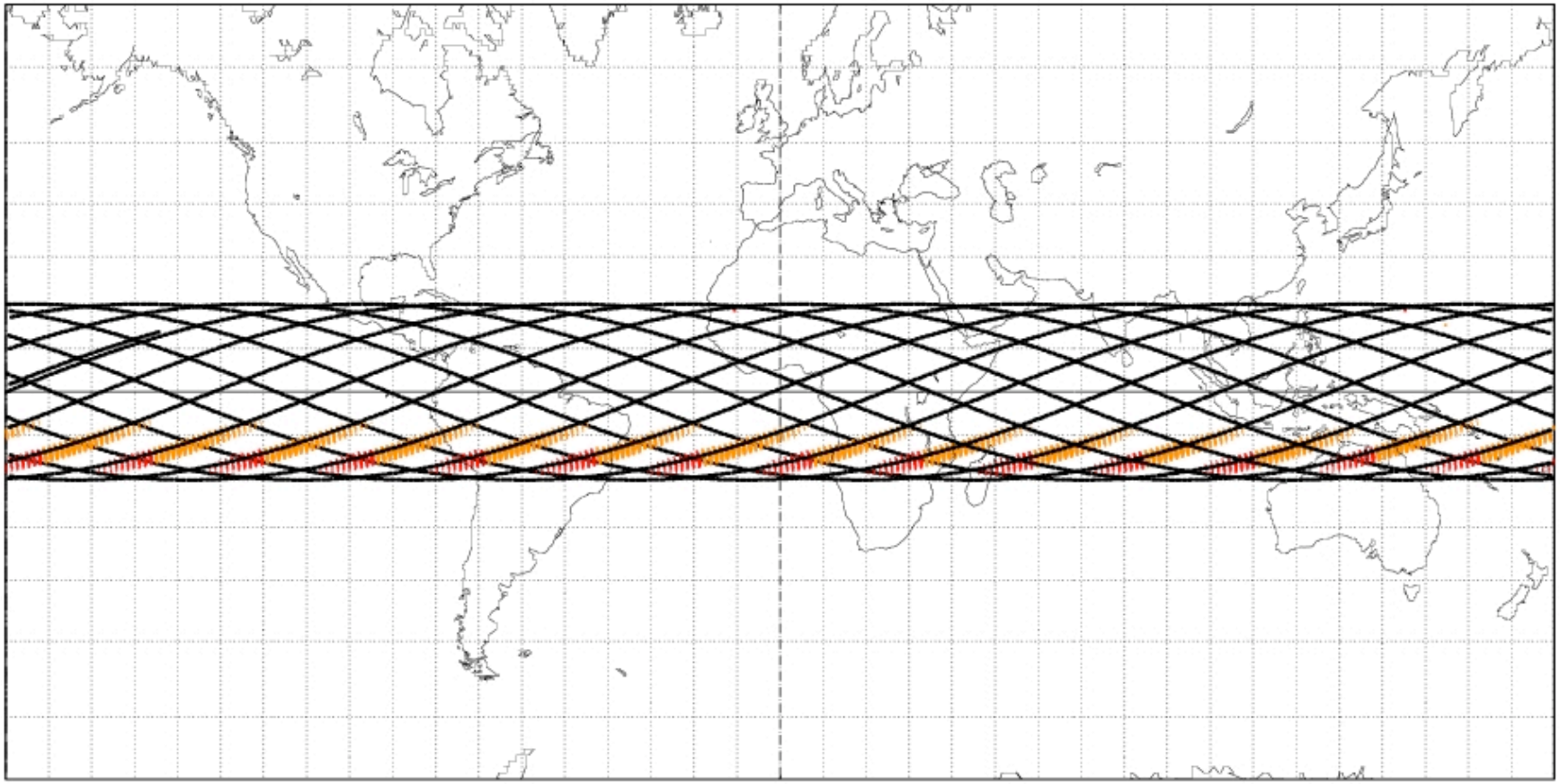
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.50 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: -180.00 ° [12:00 LMT]

Property: Conformal Aspect: Direct

⊕ T.:Cylindrical - Graticule: 10° {4.2}[+0.0/ +0.0/ +0.0] [-] GEM-T2

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 1440.0 min = 1.00 day

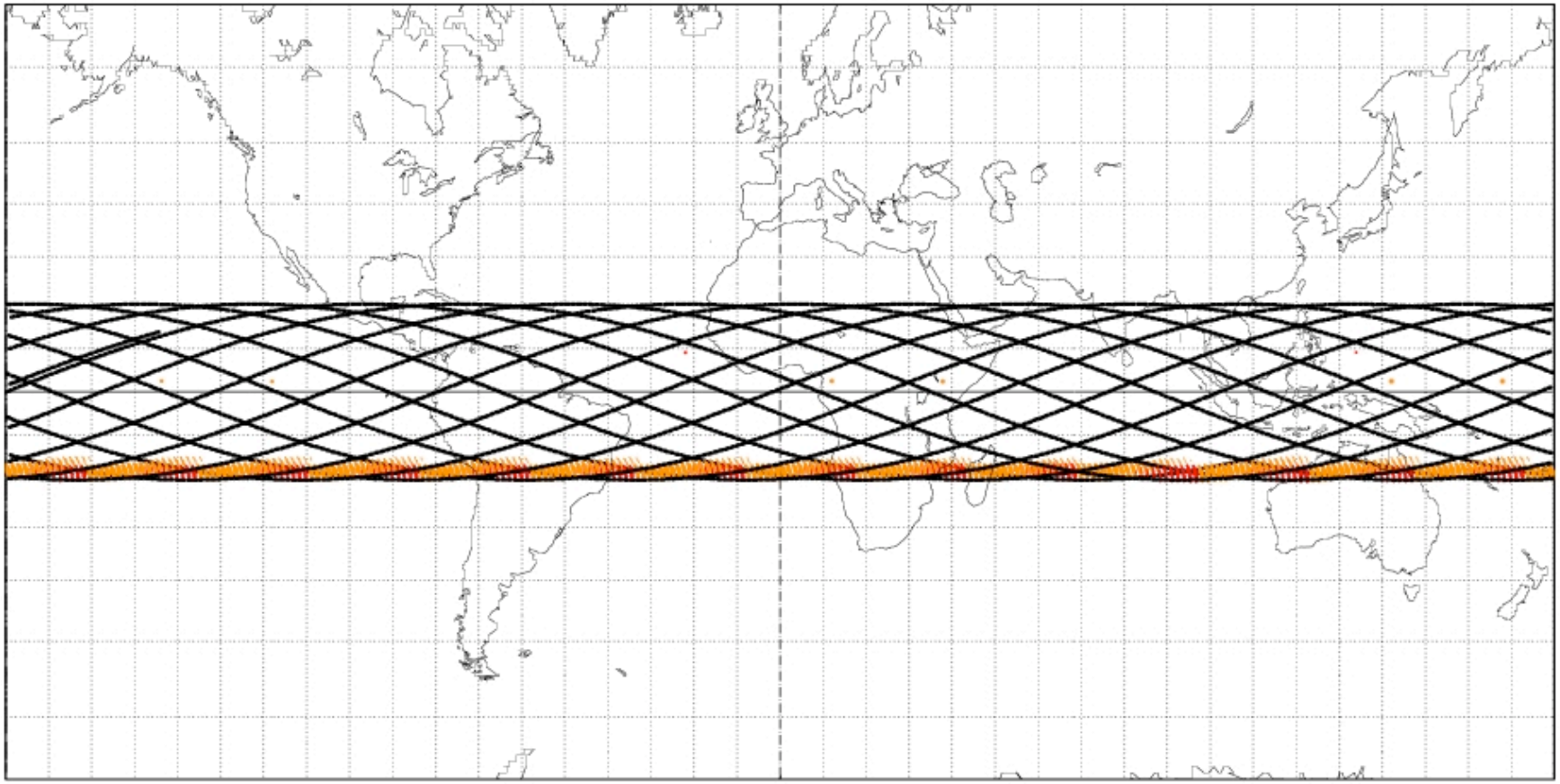
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.50 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: -180.00 ° [15:00 LMT]

Property: Conformal Aspect: Direct

⊕ T.:Cylindrical - Graticule: 10° {4.2} [+90.0/ +0.0/ -90.0] [-] GEM-T2

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 1440.0 min = 1.00 day

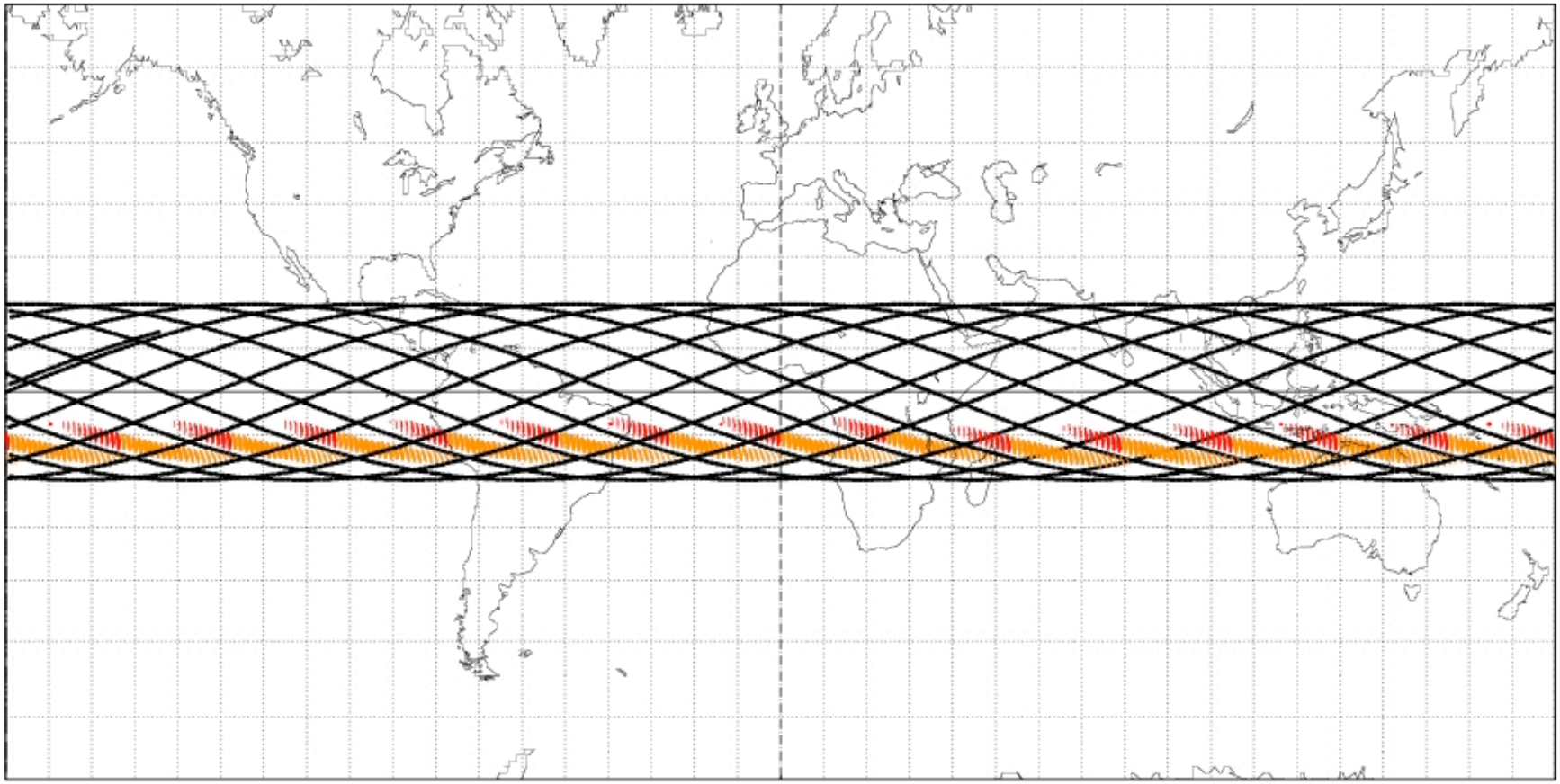
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.50 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: -180.00 ° [18:00 LMT]

Property: Conformal Aspect: Direct

⊕ T.:Cylindrical - Graticule: 10° {4.2} [+90.0/ +0.0/ -90.0] [-] GEM-T2

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 1440.0 min = 1.00 day

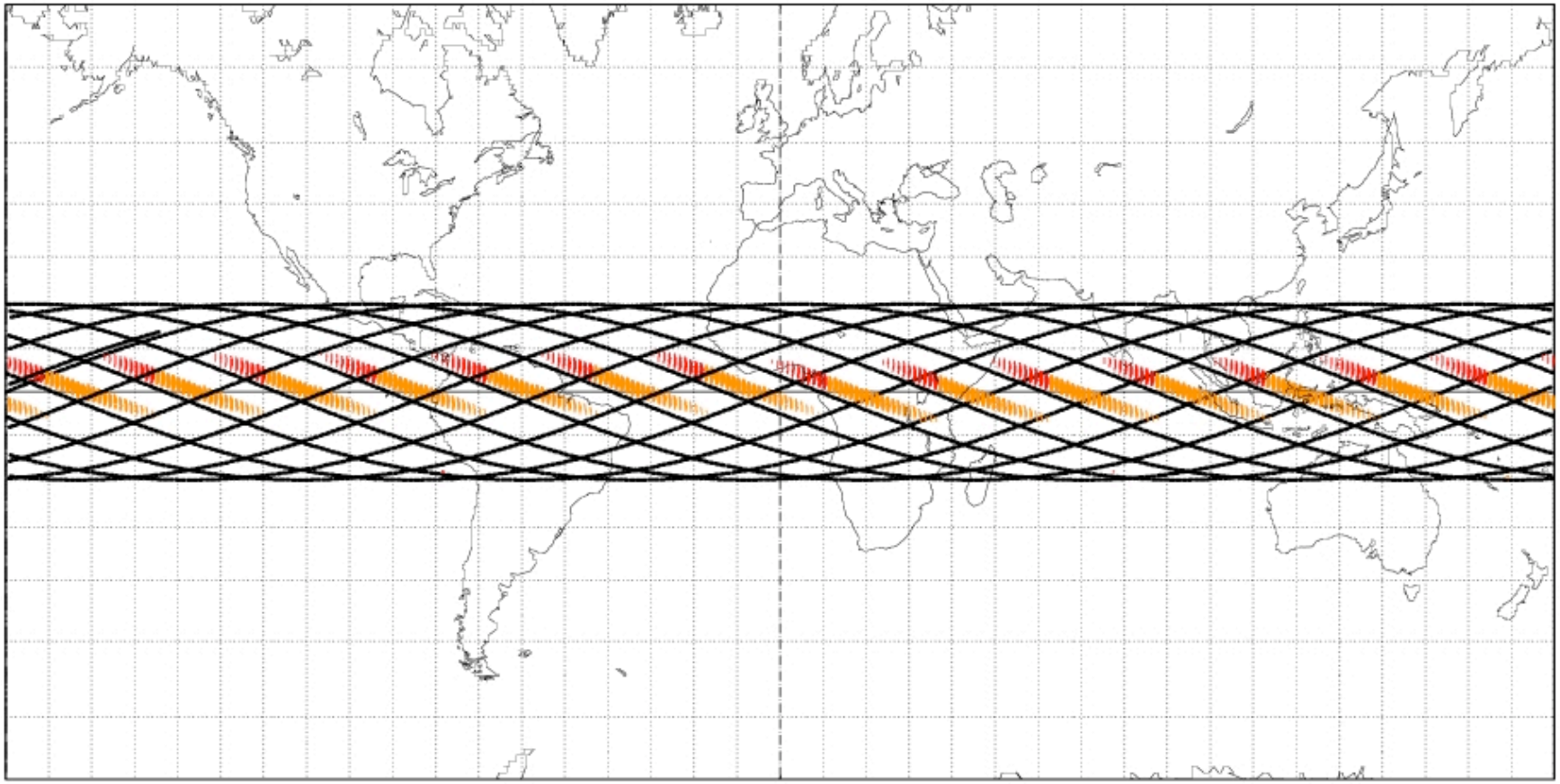
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.50 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: -180.00 ° [21:00 LMT]

Property: Conformal Aspect: Direct

⊕ T.:Cylindrical - Graticule: 10° {4.2} [+90.0/ +0.0/ -90.0] [-] GEM-T2

Ιξιων

MC ★ LMD

Ατλας

Megha-Tropiques

Orbit - Ground track - Sunglint [Zen: 15 / Azi: 15]

Altitude = 865.5 km a = 7243.678 km

Inclination = 20.00 °

>>>> Time span shown: 1440.0 min = 1.00 day

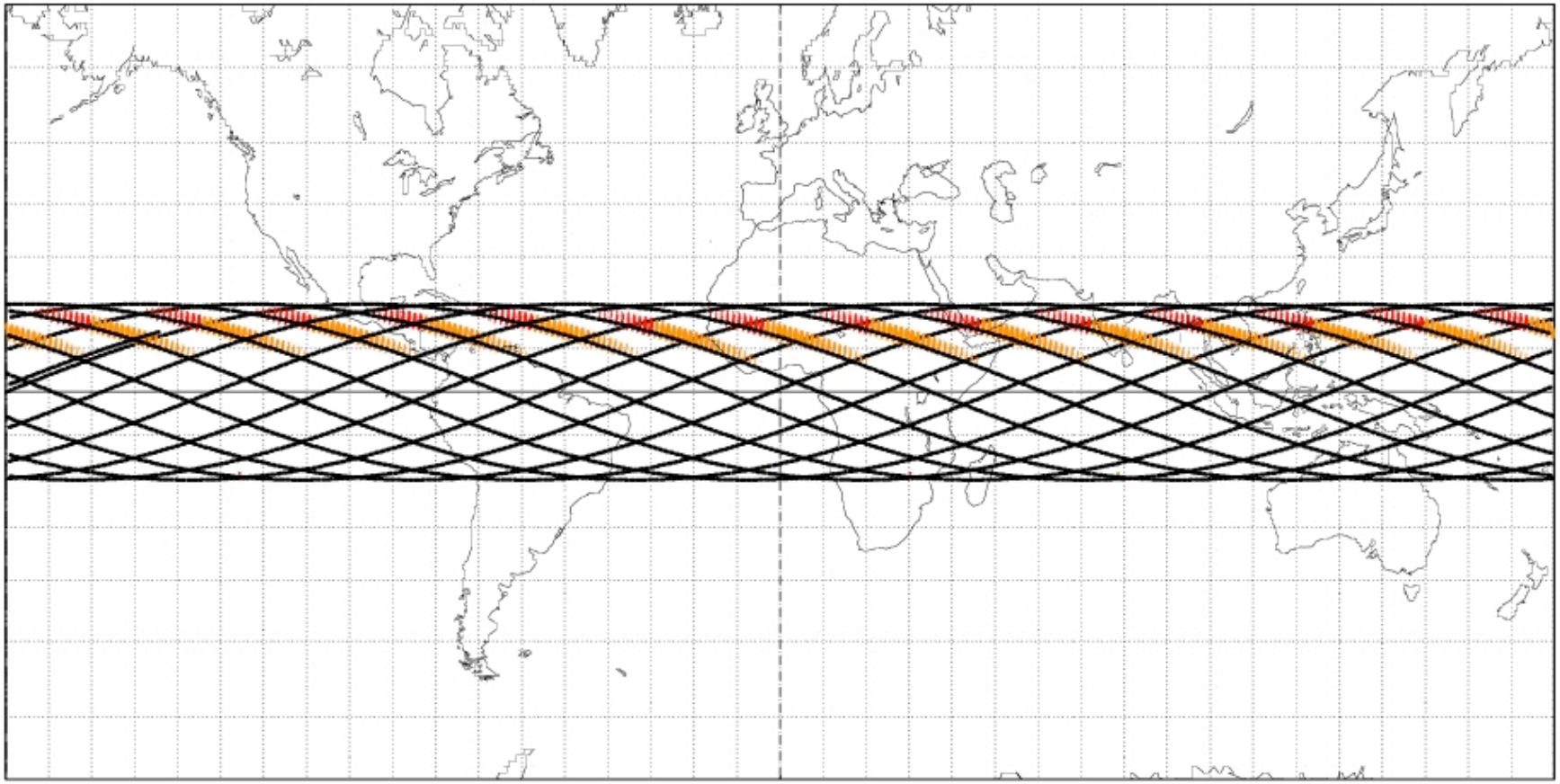
Period = 101.93 min * rev/day =14.13

Ground track - Conical swath / VZA=53.1°

** Half-aperture: 65.0° - Radius/grnd 928 km [0.50 min]

Sun Elevation (deg) -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90

21 SEP



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: -180.00 ° [00:00 LMT]

Property: Conformal Aspect: Direct

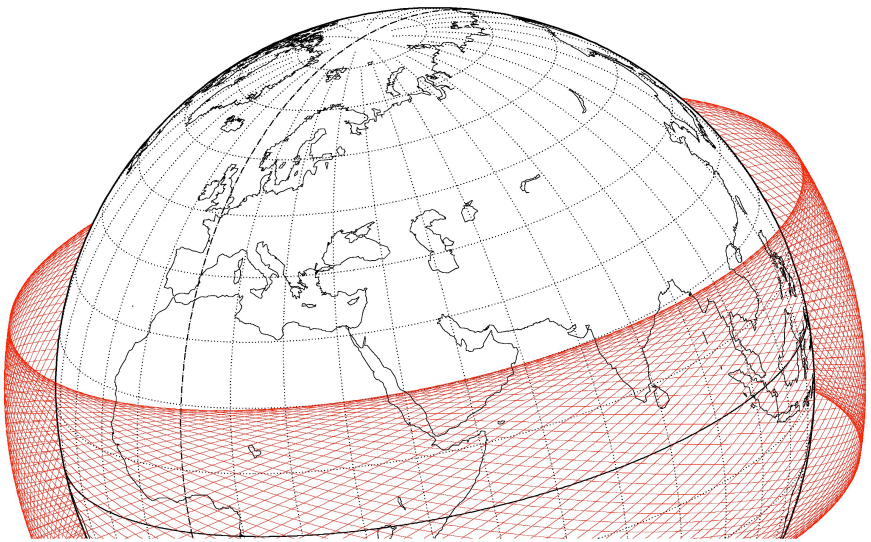
⊕ T.:Cylindrical - Graticule: 10° {4.2}[+0.0/ +0.0/ +0.0] [-] GEM-T2

Ιξιων

MC ★ LMD

Ατλας

Repeat (revisit) Cycle
(Cycle w.r.t. the Ground-track)



6

Megha-Tropiques
Orbit - Ground track

Altitude = 865.5 km a = 7243.678 km

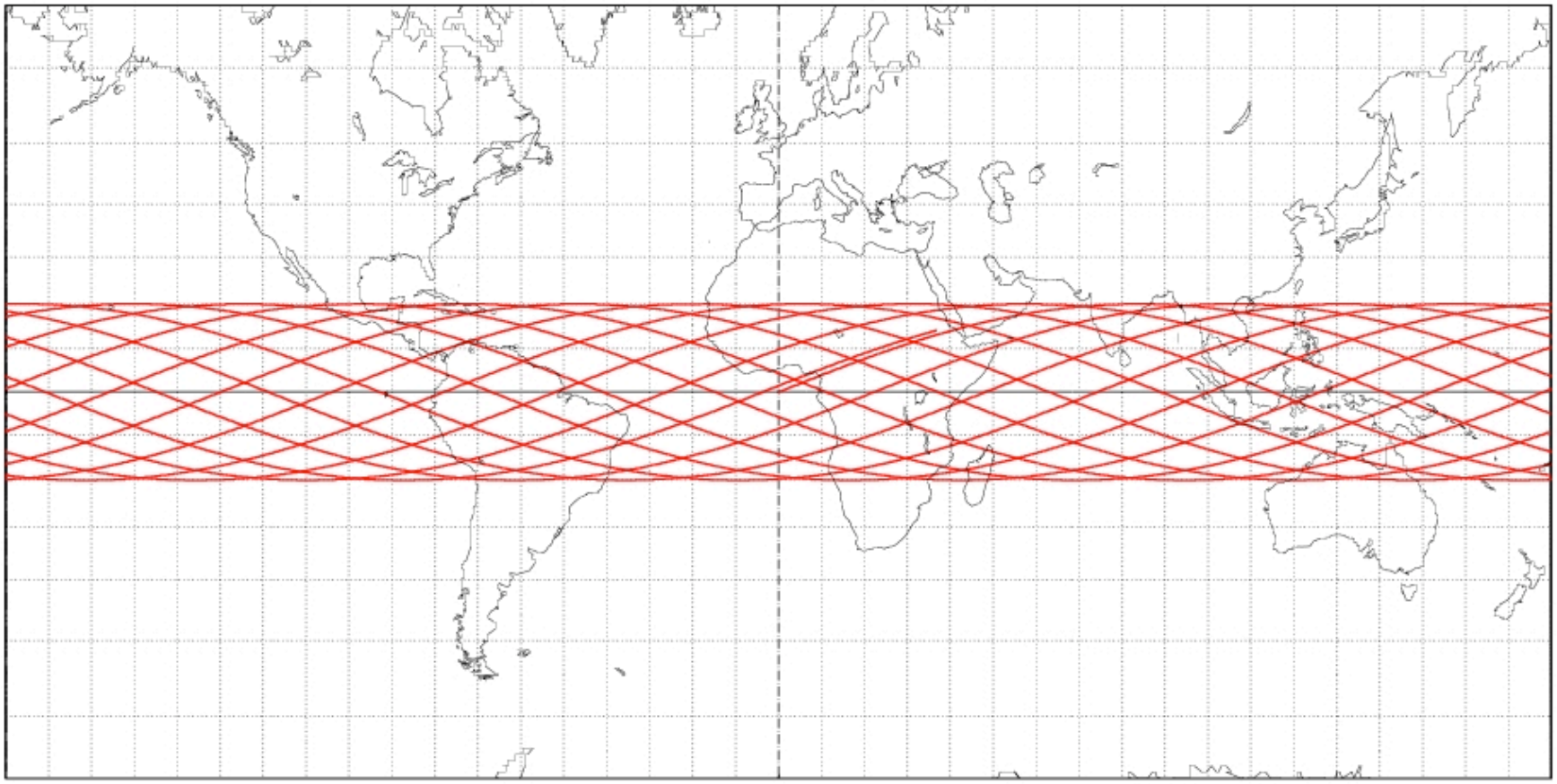
Inclination = 20.00 °

Recurrence = [14; -1; 7] 97

Period = 101.93 min * rev/day =14.13

>>>> Time span shown: 1440.0 min = 1.00 day

Equat. orbital shift = 2892.0 km (26.0 °)



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: 0.00 °

Property: Conformal Aspect: Direct App. inclin. = 21.52 °

⊕ T.:Cylindrical - Graticule: 10° {4.2}[+0.0/ +0.0/ +0.0][-] EGM96

Ιξιων
MC ★ LMD
Ατλας

Megha-Tropiques
Orbit - Ground track

Altitude = 865.5 km a = 7243.678 km

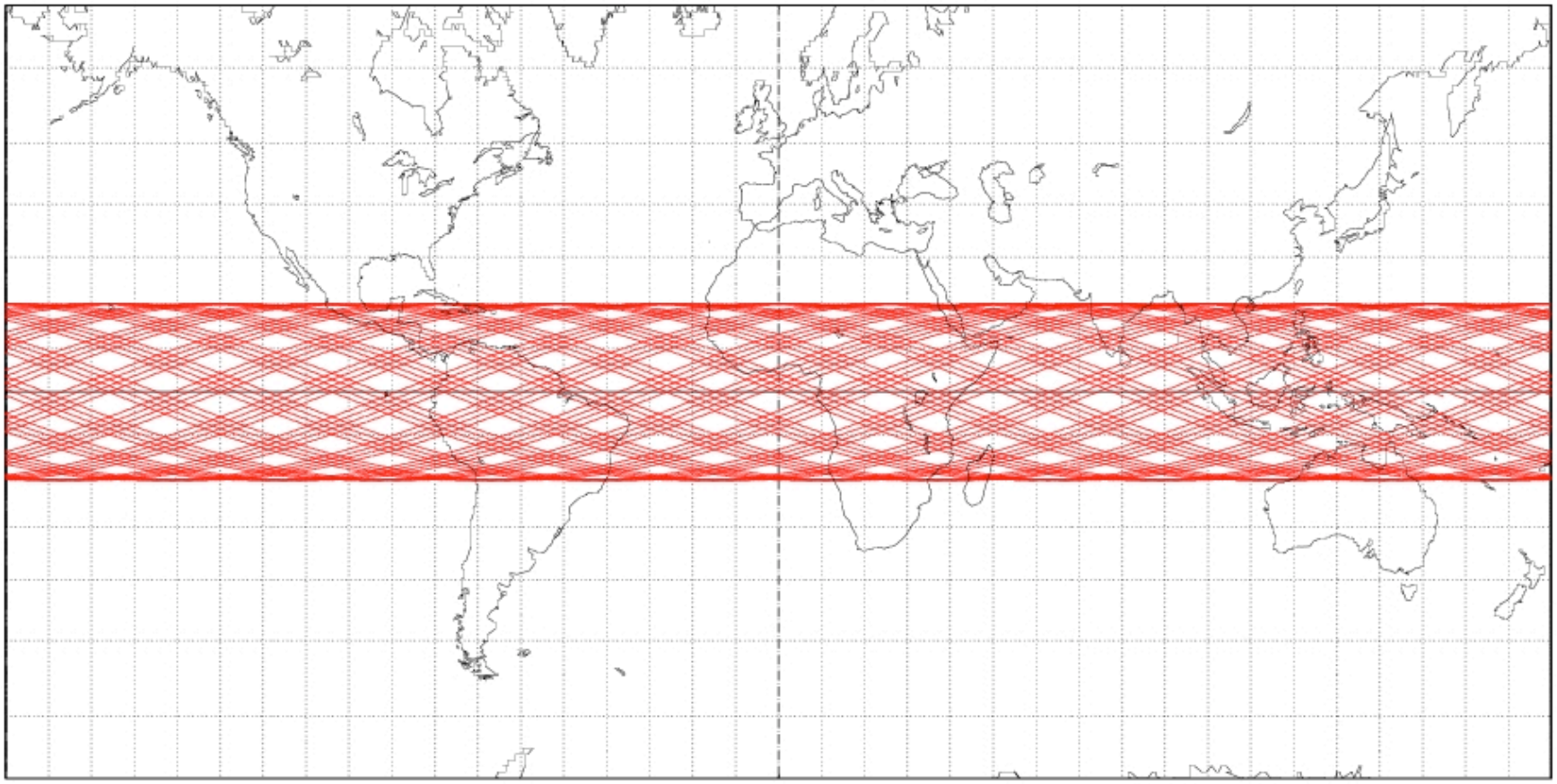
Inclination = 20.00 °

Recurrence = [14; -1; 7] 97

Period = 101.93 min * rev/day =14.13

>>>> Time span shown: 5760.0 min = 4.00 days

Equat. orbital shift = 2892.0 km (26.0 °)



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: 0.00 °

Property: Conformal Aspect: Direct App. inclin. = 21.52 °

⊕ T.:Cylindrical - Graticule: 10° {4.2}[+0.0/ +0.0/ +0.0][-] EGM96

Ιξιων
MC ★ LMD
Ατλας

Megha-Tropiques
Orbit - Ground track

Altitude = 865.5 km a = 7243.678 km

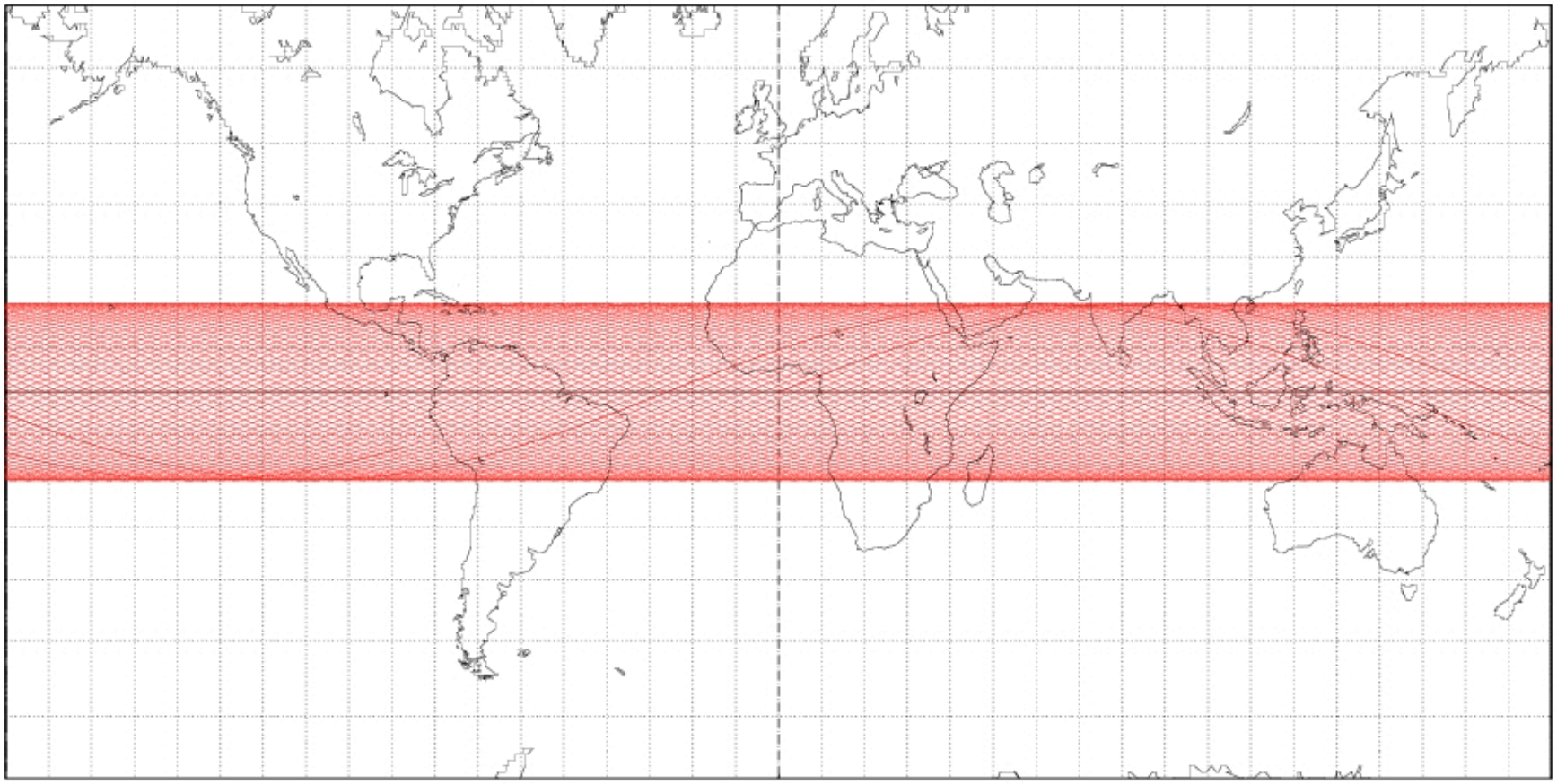
Inclination = 20.00 °

Recurrence = [14; -1; 7] 97

Period = 101.93 min * rev/day =14.13

>>>> Time span shown: 7.00 days

Equat. orbital shift = 2892.0 km (26.0 °)



Projection: Mercator Project. centre: 0.0 ° ; 0.0 ° Asc. node: 0.00 °

Property: Conformal Aspect: Direct App. inclin. = 21.52 °

⊕ T.:Cylindrical - Graticule: 10° {4.2}[+0.0/ +0.0/ +0.0][-] EGM96

Ιξιων
MC ★ LMD
Ατλας

IXION

Attrative body

Terre

Information Cancel

Satellite

MEGHA-TROPIQUES

Norad Orbit Recurrence Annexes

Cancel

Type of display

ORBITOGRAPHY : Ground Track (Day noted)

Cancel

Orbit Representation

Cancel Modify

Swaths

Cancel Modify

Options

(•) Enhanced ( ) Default value

Map

(•) Google Map ( ) Carto Atlas

( ) Google Earth

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Karim RAMAGE
L.M.D. / I.P.S.L. / C.N.R.S. / U.P.M.C.

MEGHA-TROPIQUES

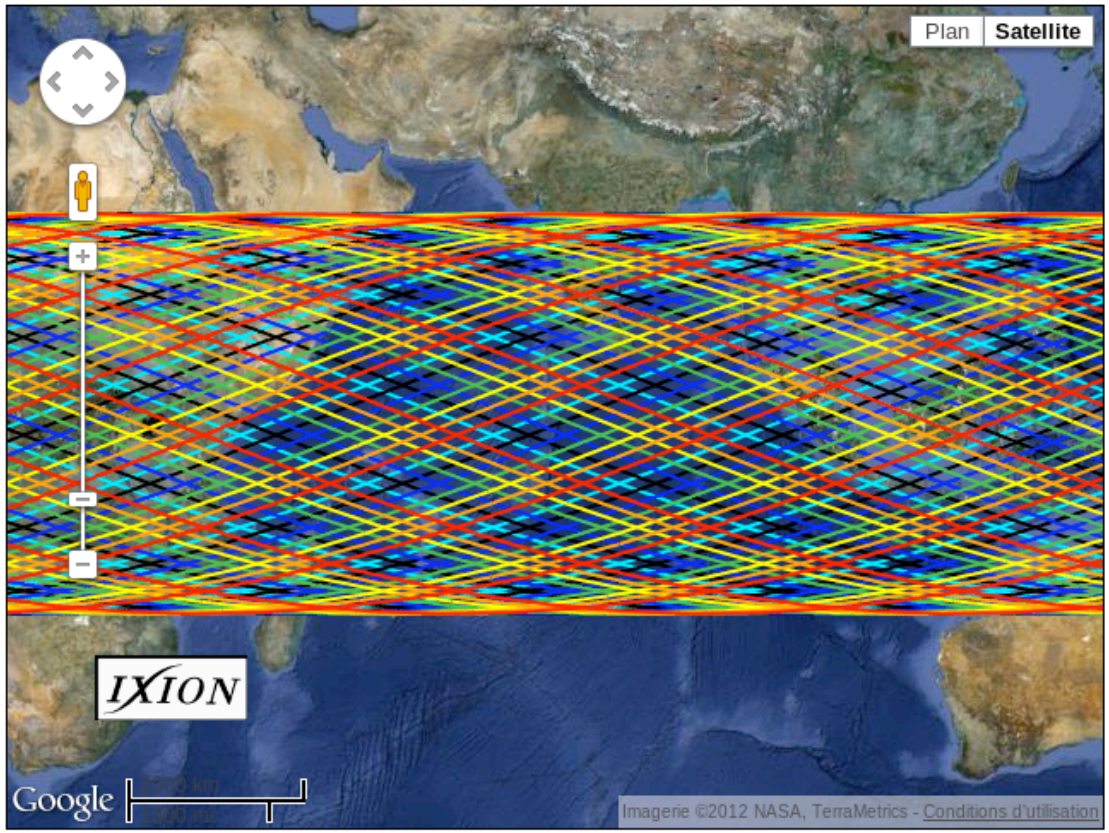
2012 10 18 00:00:00 UTC >>> 8.00 days
Recurrence = [14; -1; 7] 97
[NORAD] 2012 10 17 09:33:01 UTC [AscN]
REVOL. Init.: 5241 / Repr.: 5249

INCLINATION = 19.97° a = 7243.523 km
Period = 101.93 min e = 0.001111
Apogee ALTITUDE = 876 km ; Perigee ALTITUDE = 860 km;
Perigee Arg. : 93.37°

DAY 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16

GO

ex: Paris ex: 48.85/2.35 (lat/lng)

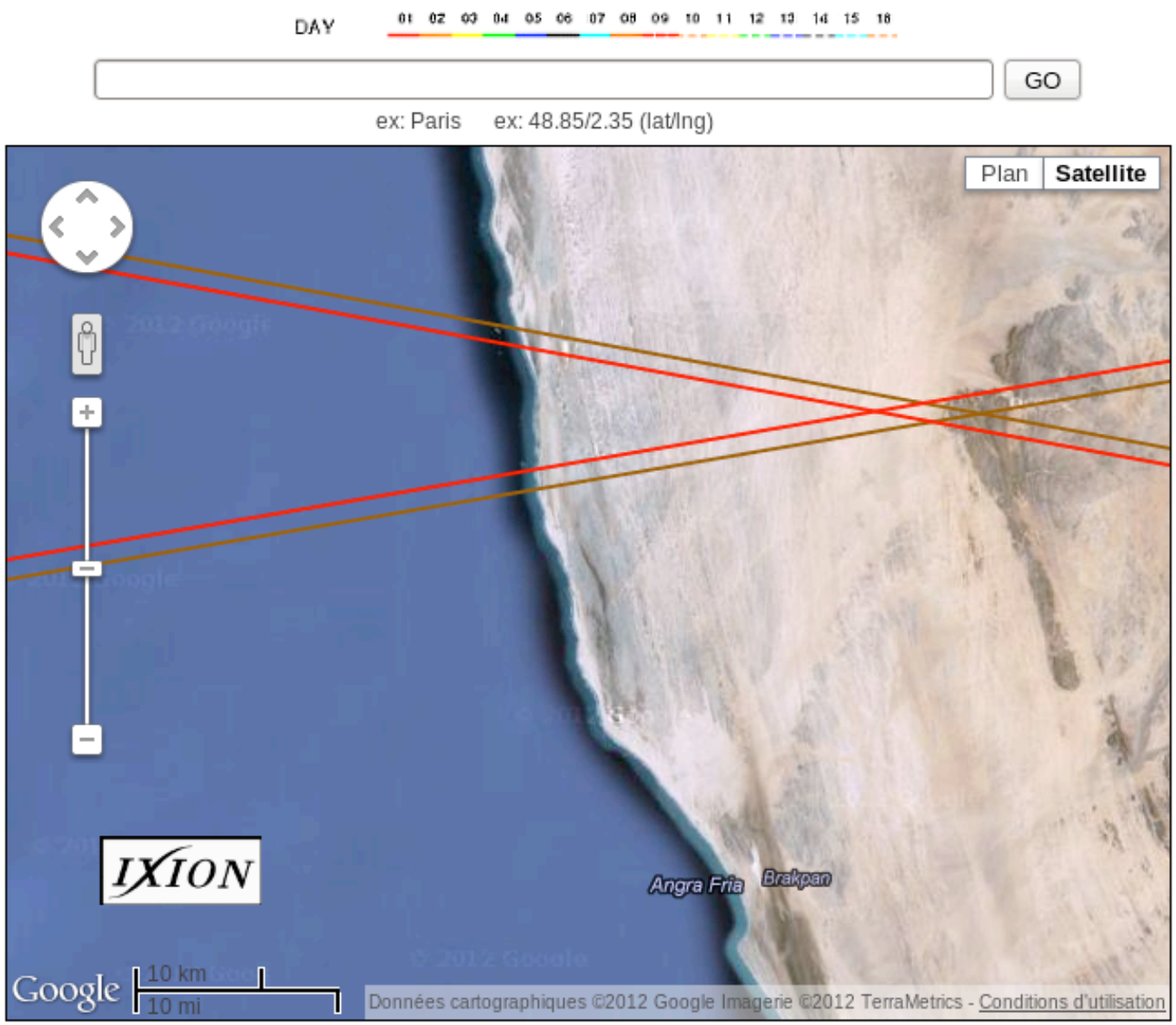


>Download Google Earth KMZ<

MEGHA-TROPIQUES

2012 10 18 00:00:00 UTC >>> 8.00 days
Recurrence = [14; -1; 7] 97
[NORAD] 2012 10 17 09:33:01 UTC [AscN]
REVOL. Init.: 5241 / Repr.: 5249

INCLINATION = 19.97° a = 7243.523 km
Period = 101.93 min e = 0.001111
Apogee ALTITUDE = 876 km ; Perigee ALTITUDE = 860 km;
Perigee Arg. : 93.37°

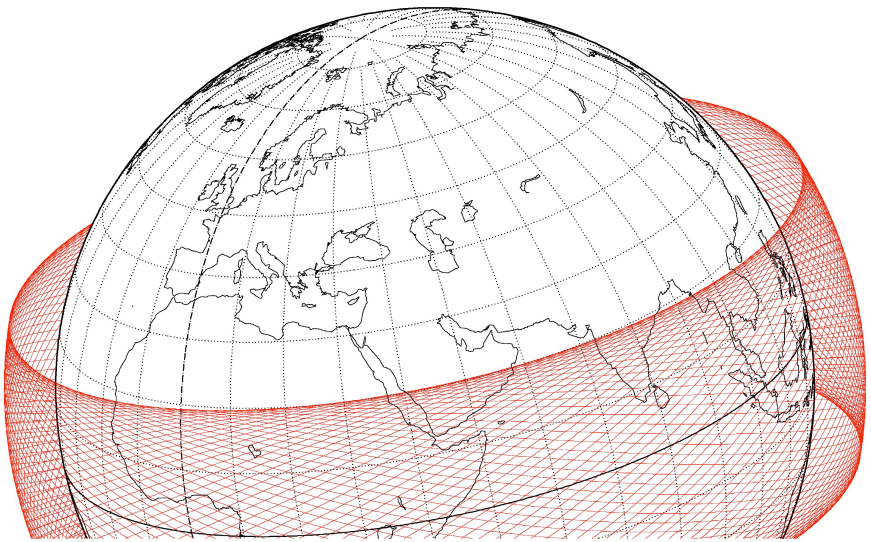


Ground-track:

Difference for
Day D
and
Day D+7

about 2 km

Actual Orbital Elements for MT s/c and Stationkeeping



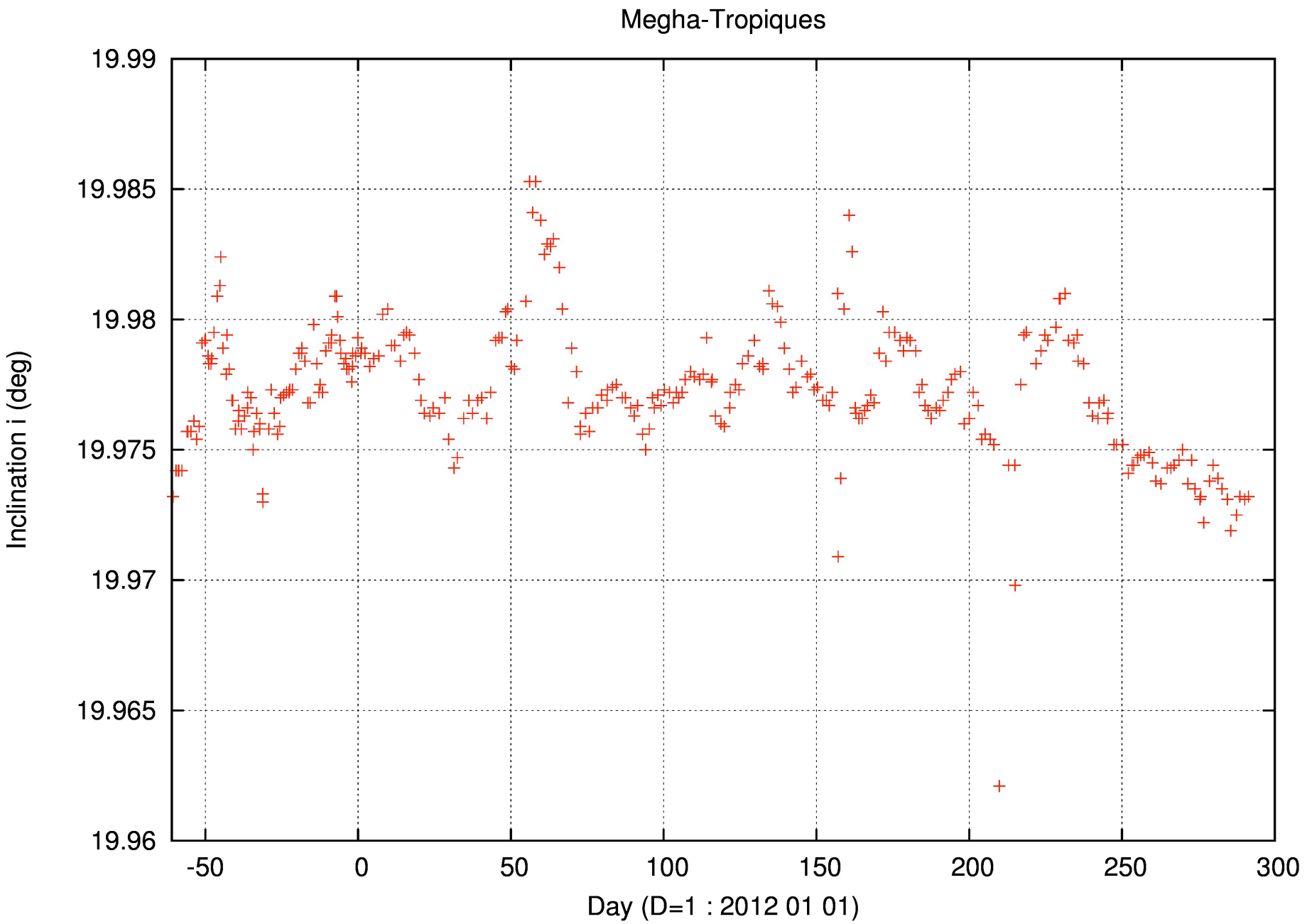
7

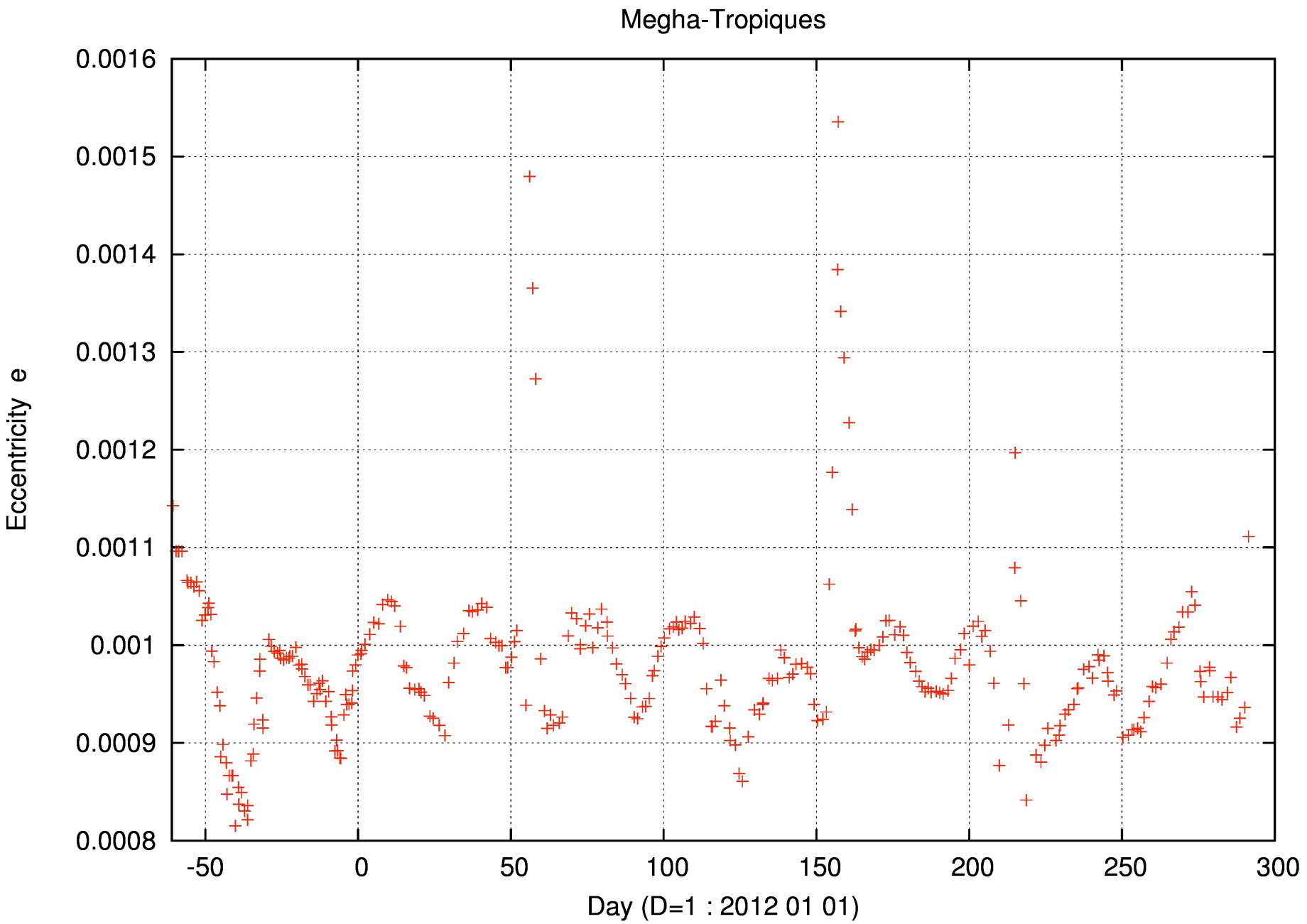
NORAD
Two-line Elements (TLE)

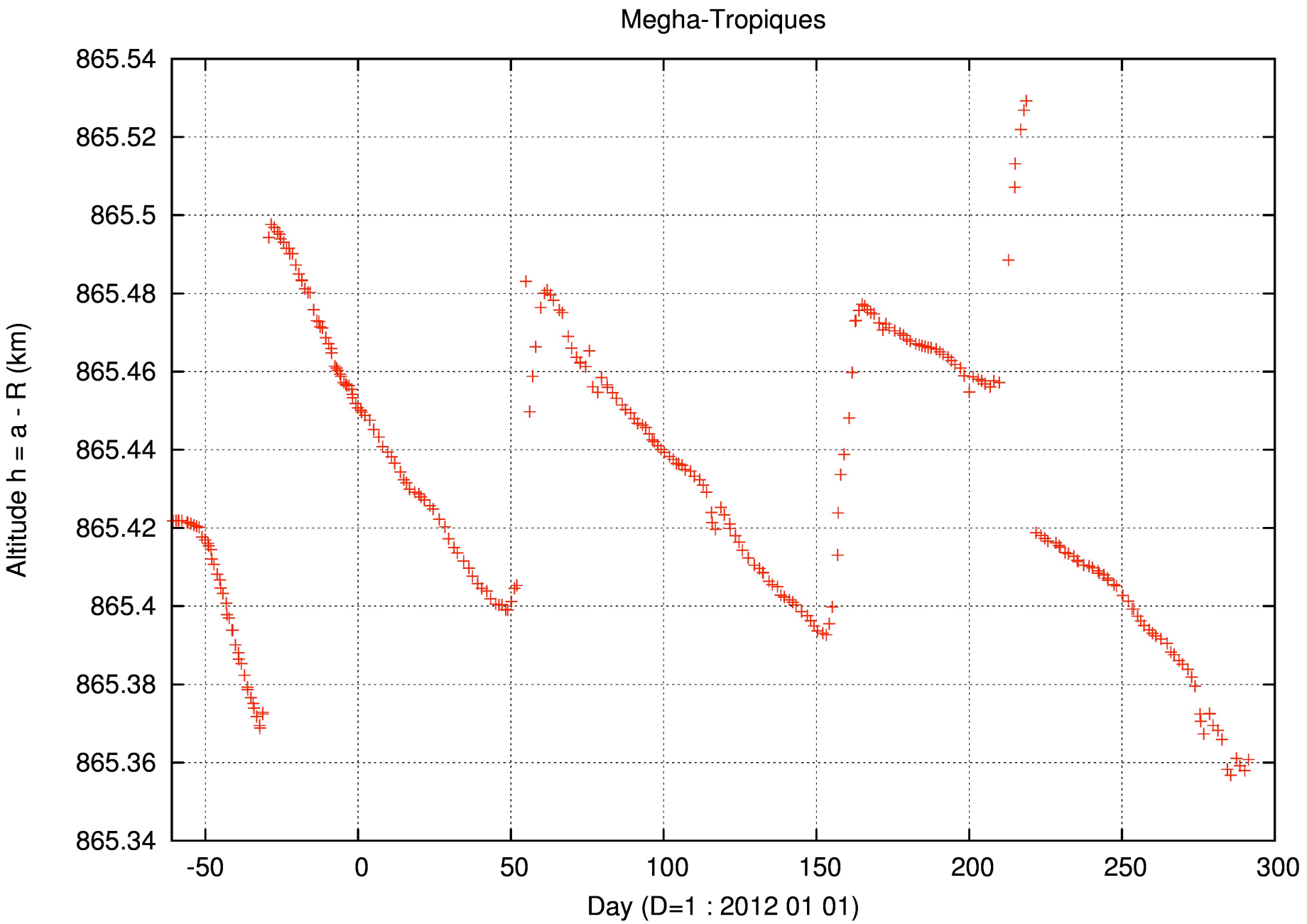
- a — semi-major axis
- i — inclination
- e — eccentricity
- Ω, ω, M — angles
- n — number of revolutions per day

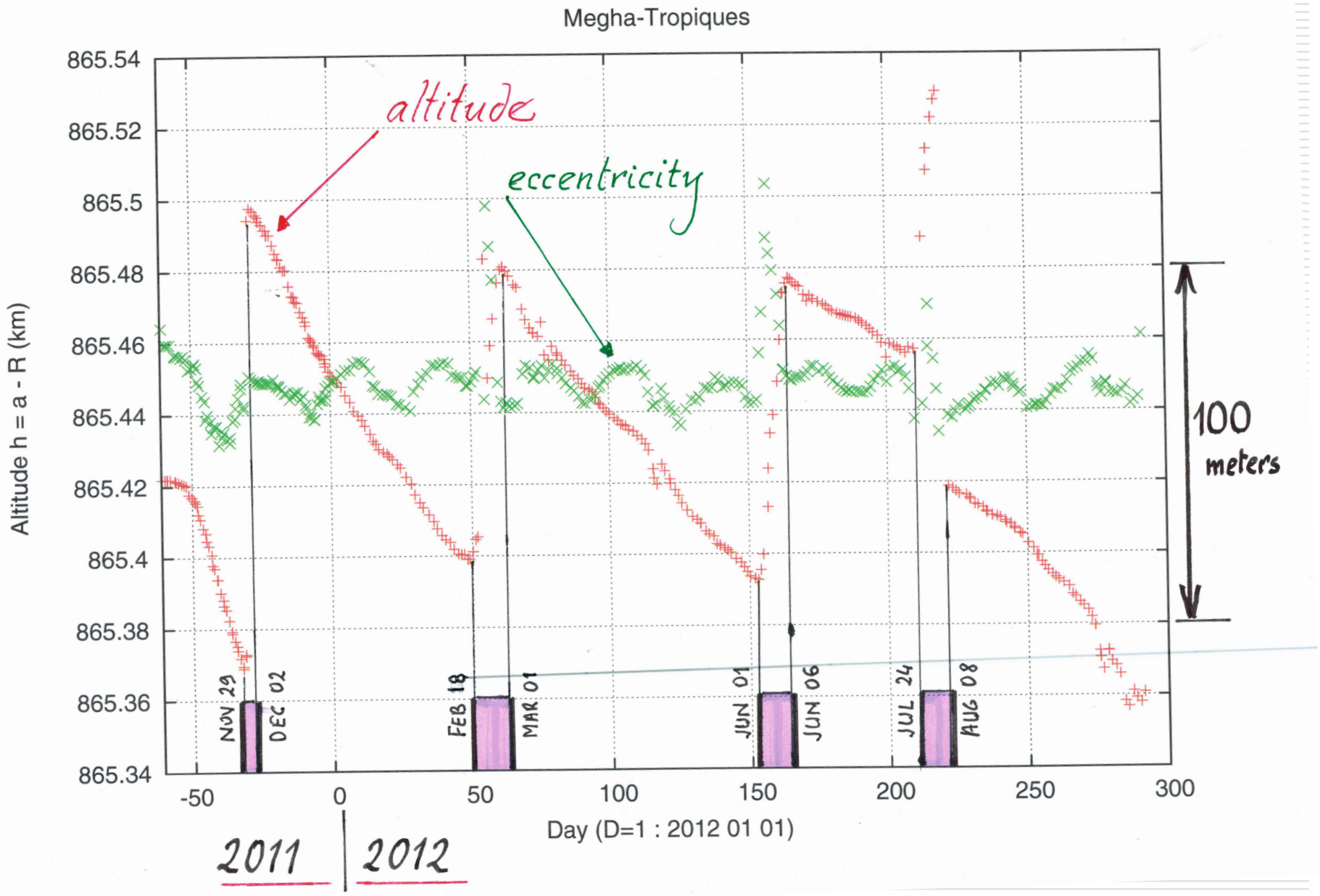
- i, e and angles are given directly by TLE
- By an iterative method (perturbed equations of motion), we obtain the value of a
- h — equivalent altitude: h = a – R

  R = Earth equatorial radius


Megha-Tropiques
Inclination i (deg)
19.99
19.985
19.98
19.975
19.97
19.965
19.96
-50
0
50
100
150
200
250
300
Day (D=1 : 2012 01 01)


Megha-Tropiques
Eccentricity e
0.0016
0.0015
0.0014
0.0013
0.0012
0.0011
0.001
0.0009
0.0008
-50
0
50
100
150
200
250
300
Day (D=1 : 2012 01 01)


Megha-Tropiques
865.54
865.52
865.5
865.48
865.46
865.44
865.42
865.4
865.38
865.36
865.34
Altitude h = a - R (km)
-50
0
50
100
150
200
250
300
Day (D=1 : 2012 01 01)


Megha-Tropiques
altitude
eccentricity
100 meters
Altitude h = a - R (km)
865.54
865.52
865.5
865.48
865.46
865.44
865.42
865.4
865.38
865.36
865.34
-50
0
50
100
150
200
250
300
Day (D=1 : 2012 01 01)
NOV 29
DEC 02
FEB 18
MAR 01
JUN 01
JUN 06
JUL 24
AUG 08
2011
2012

IXION

Attrative body

Terre

Information Cancel

Satellite

MEGHA-TROPIQUES

Norad Orbit Recurrence Annexes

Cancel

Type of display

ORBITOGRAPHY : Real Time Satellite Tracking

Cancel

Map

Google Map Carto Atlas

Google Earth

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MEGHA-TROPIQUES

Date : Fri, 19 Oct 2012 13:46:12 UTC
Longitude = 0004.650° -> 14:05 LMT
Latitude = -020.052°
Altitude = 874.779 km
Satellite Speed = 7.409 km/s
Ground Track = 6.080 km/s

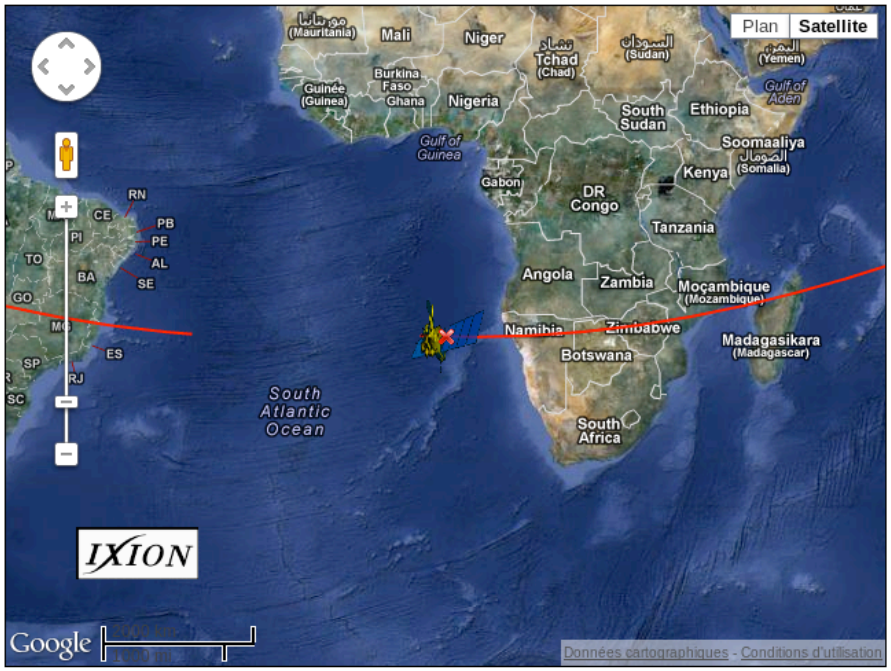
INCLINATION = 19.97° a = 7243.523 km
Period = 101.93 min e = 0.001111
Perigee Arg. : 93.37°

Satellite in day light time

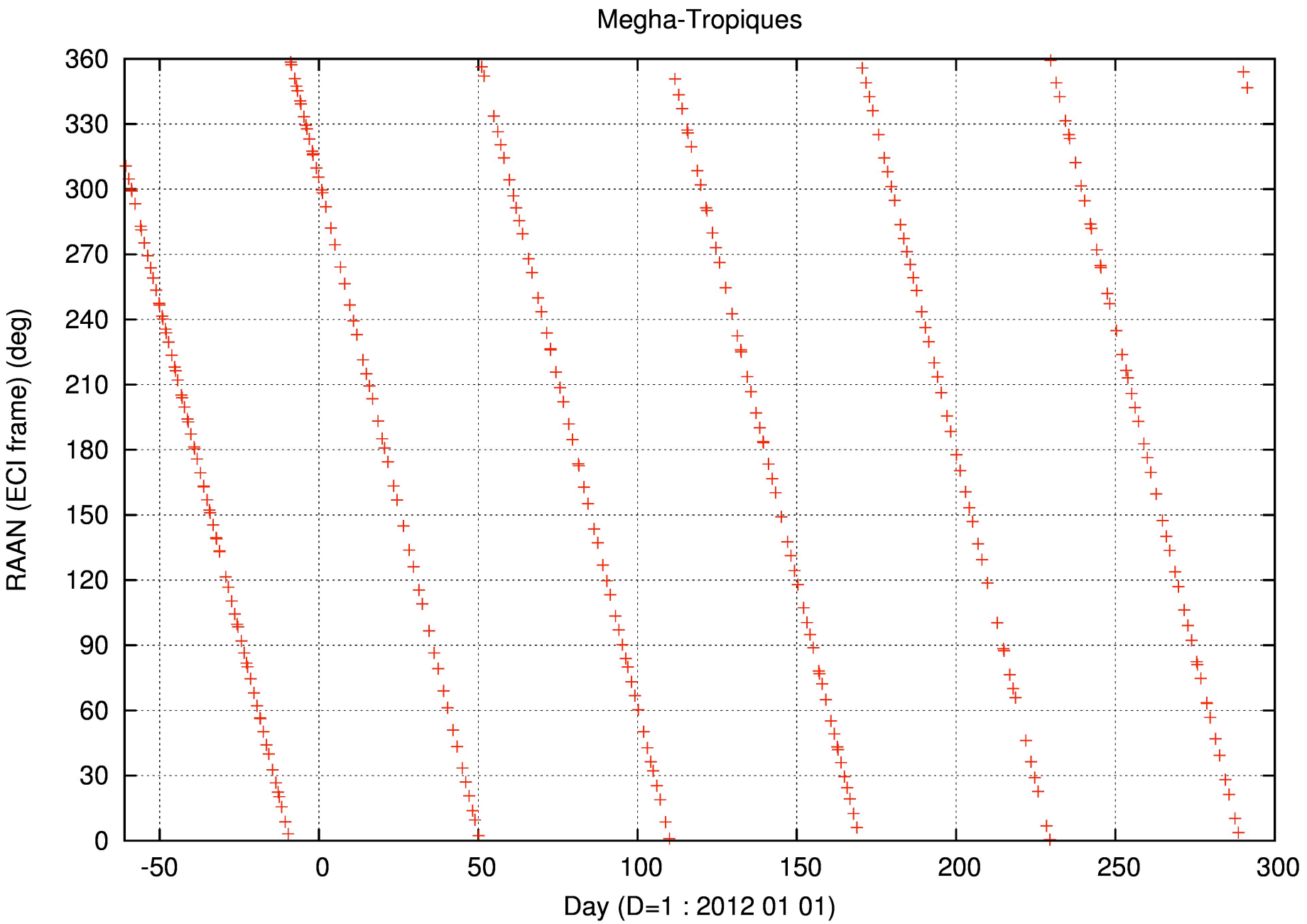
☑ Keep satellite centered

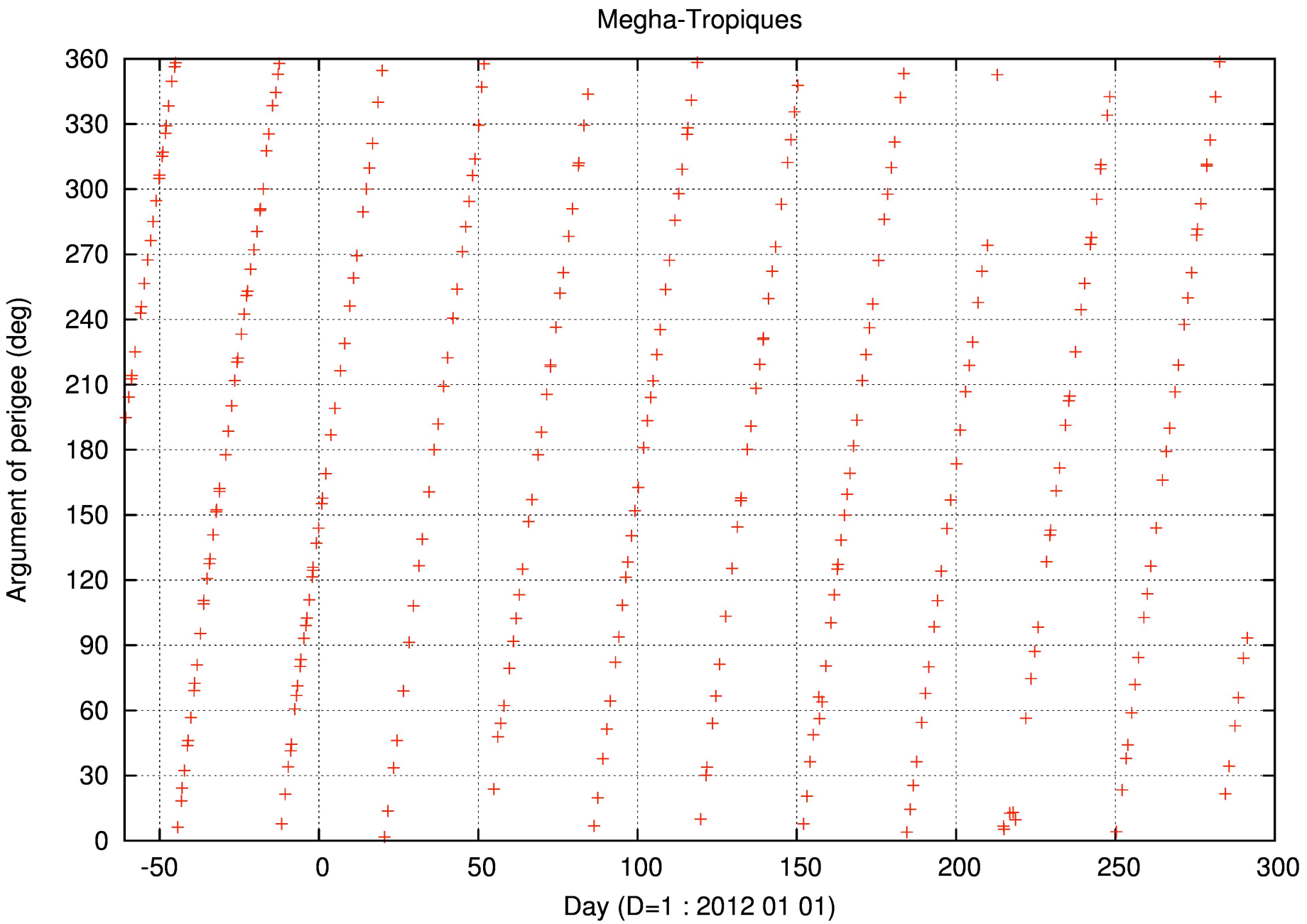
☐ Draw footprint, with a step of:

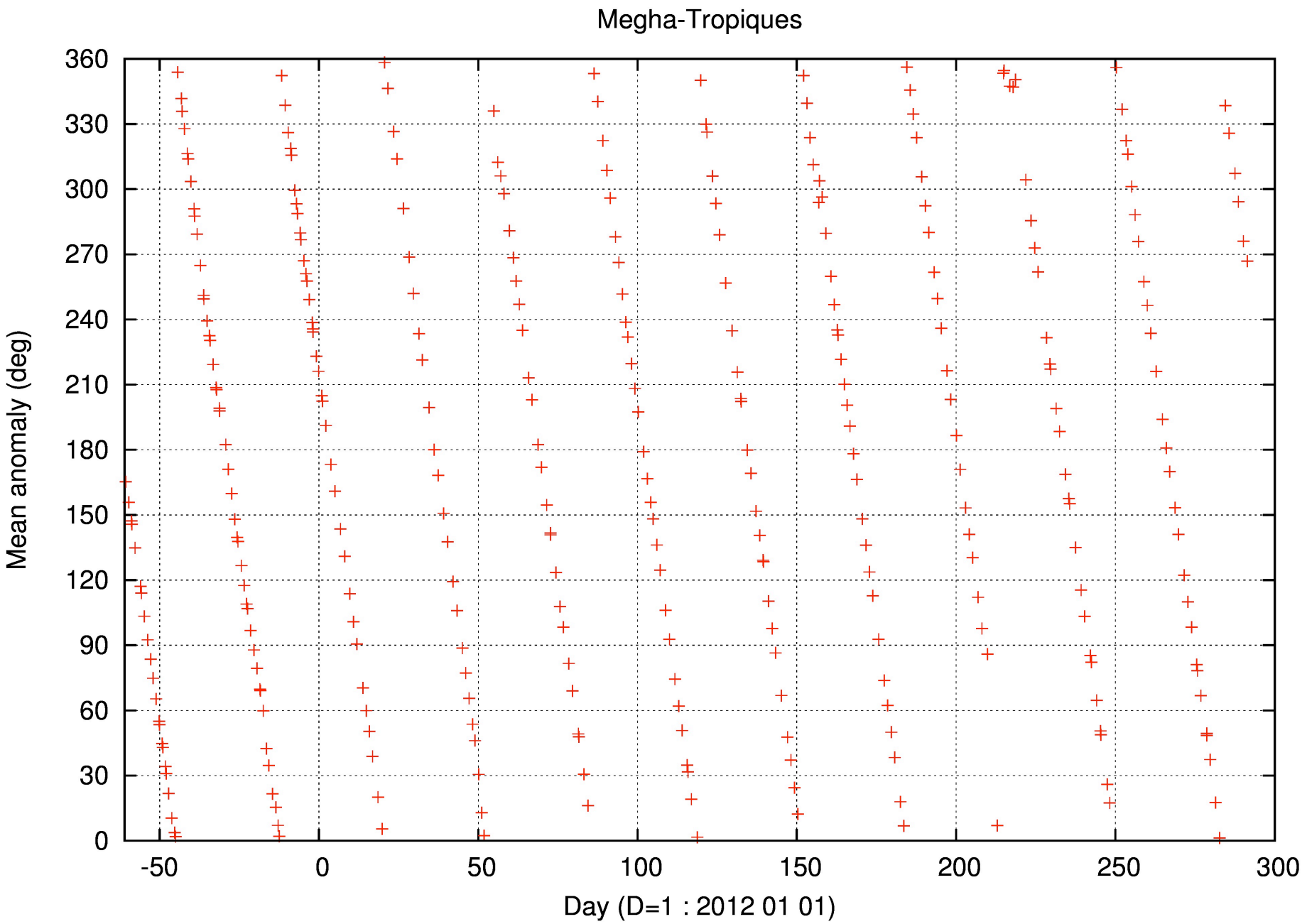
☑ Draw the track of satellite

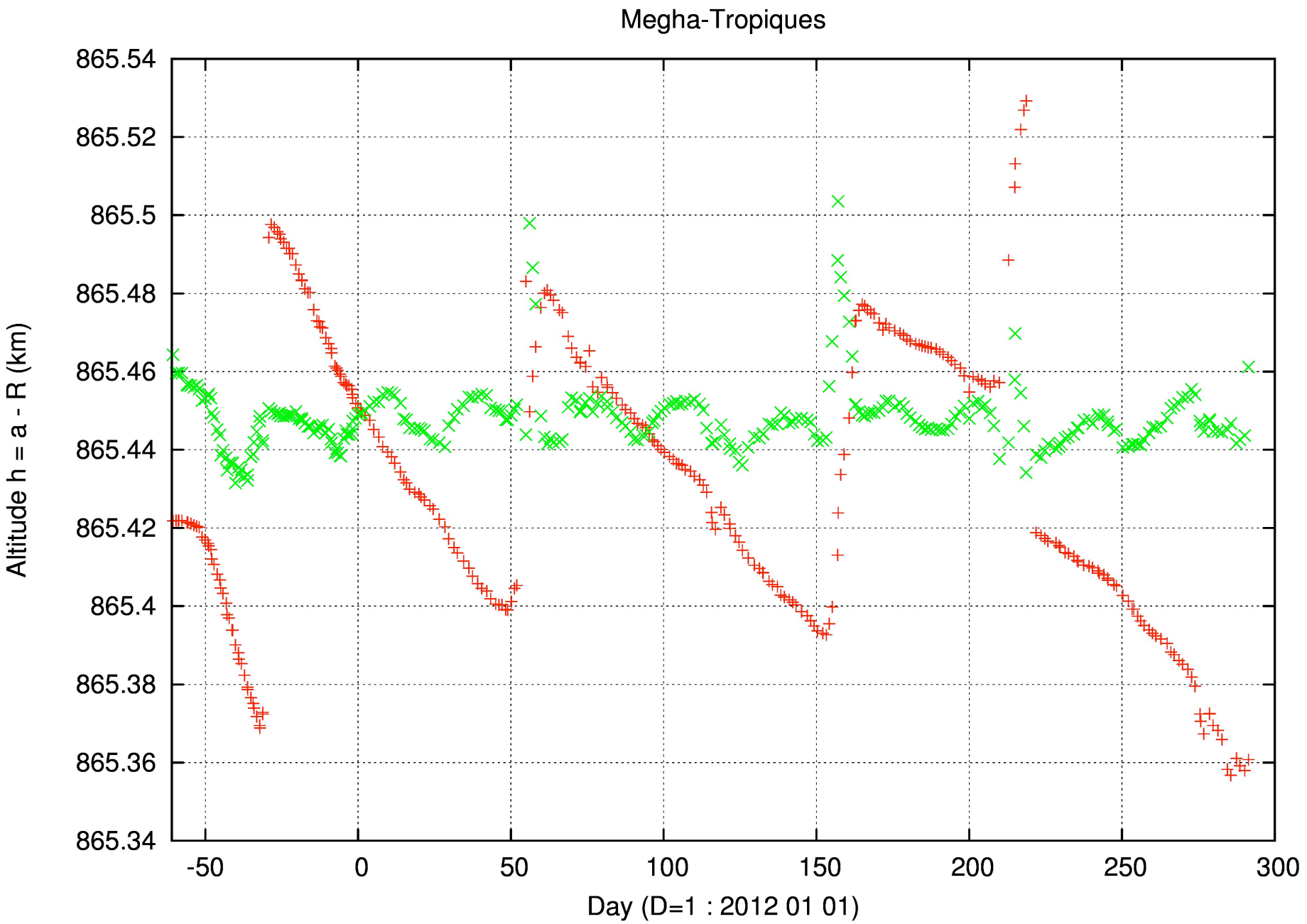


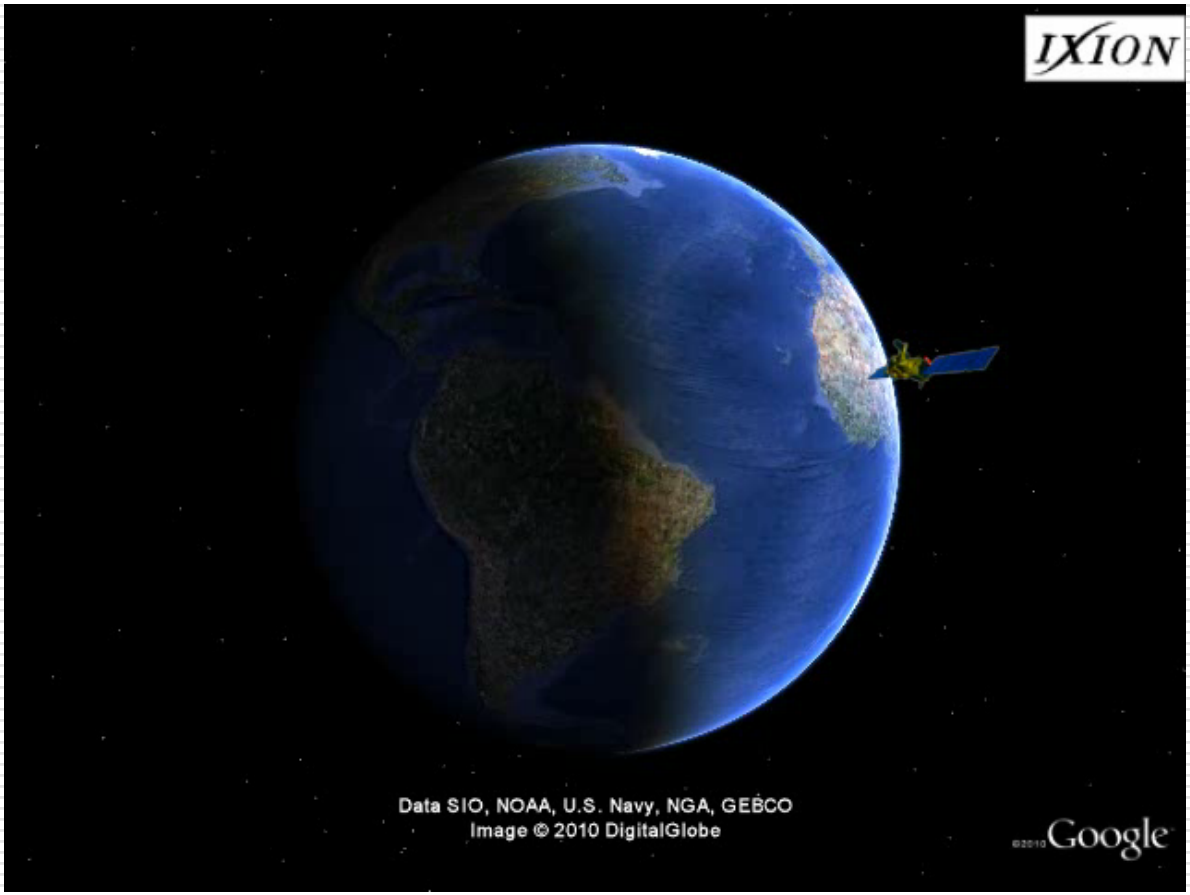
Back-up slides

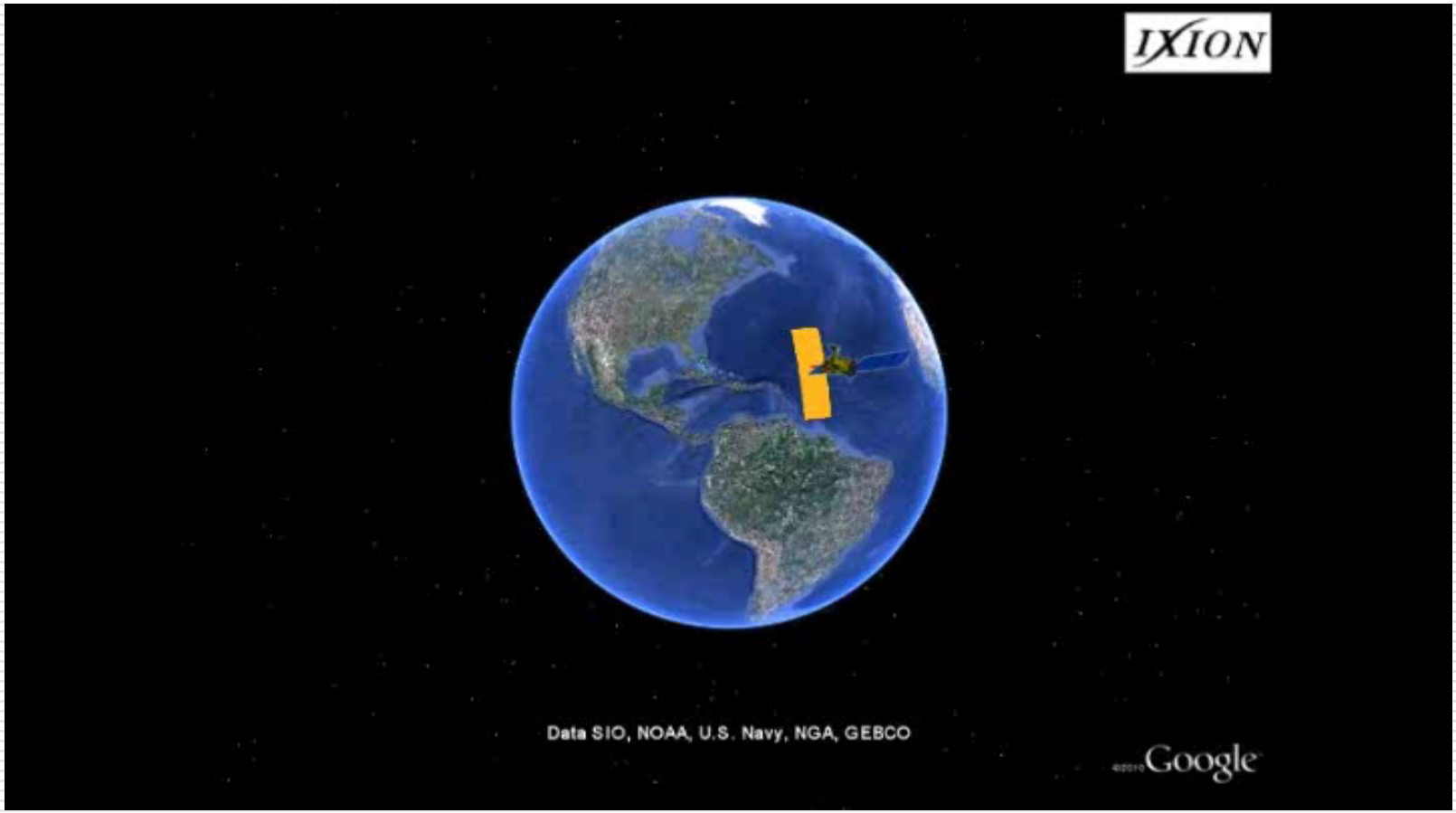

Megha-Tropiques
RAAN (ECI frame) (deg)
360
330
300
270
240
210
180
150
120
90
60
30
0
-50
0
50
100
150
200
250
300
Day (D=1 : 2012 01 01)

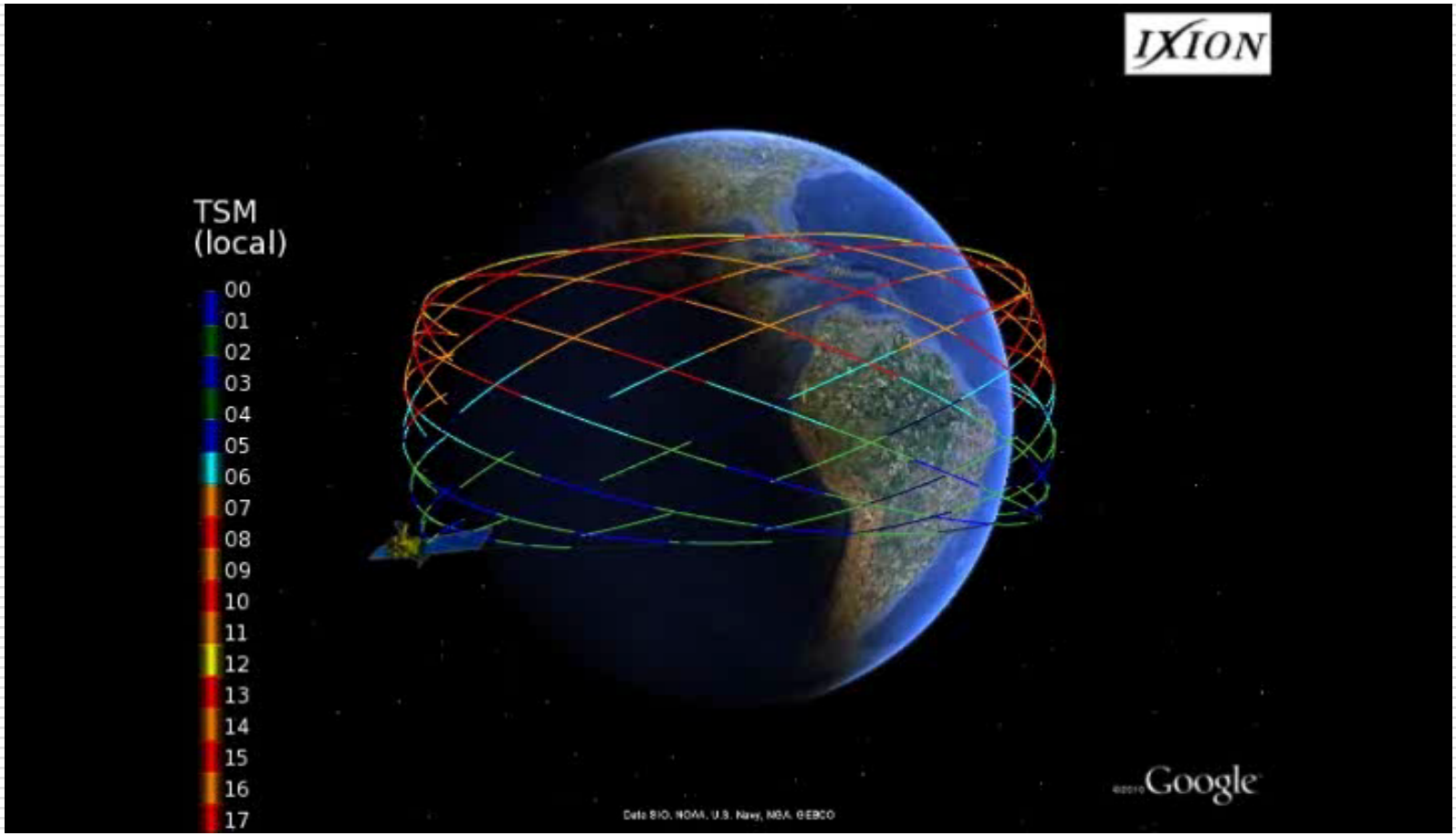

Megha-Tropiques
Argument of perigee (deg)
360
330
300
270
240
210
180
150
120
90
60
30
0
-50
0
50
100
150
200
250
300
Day (D=1 : 2012 01 01)

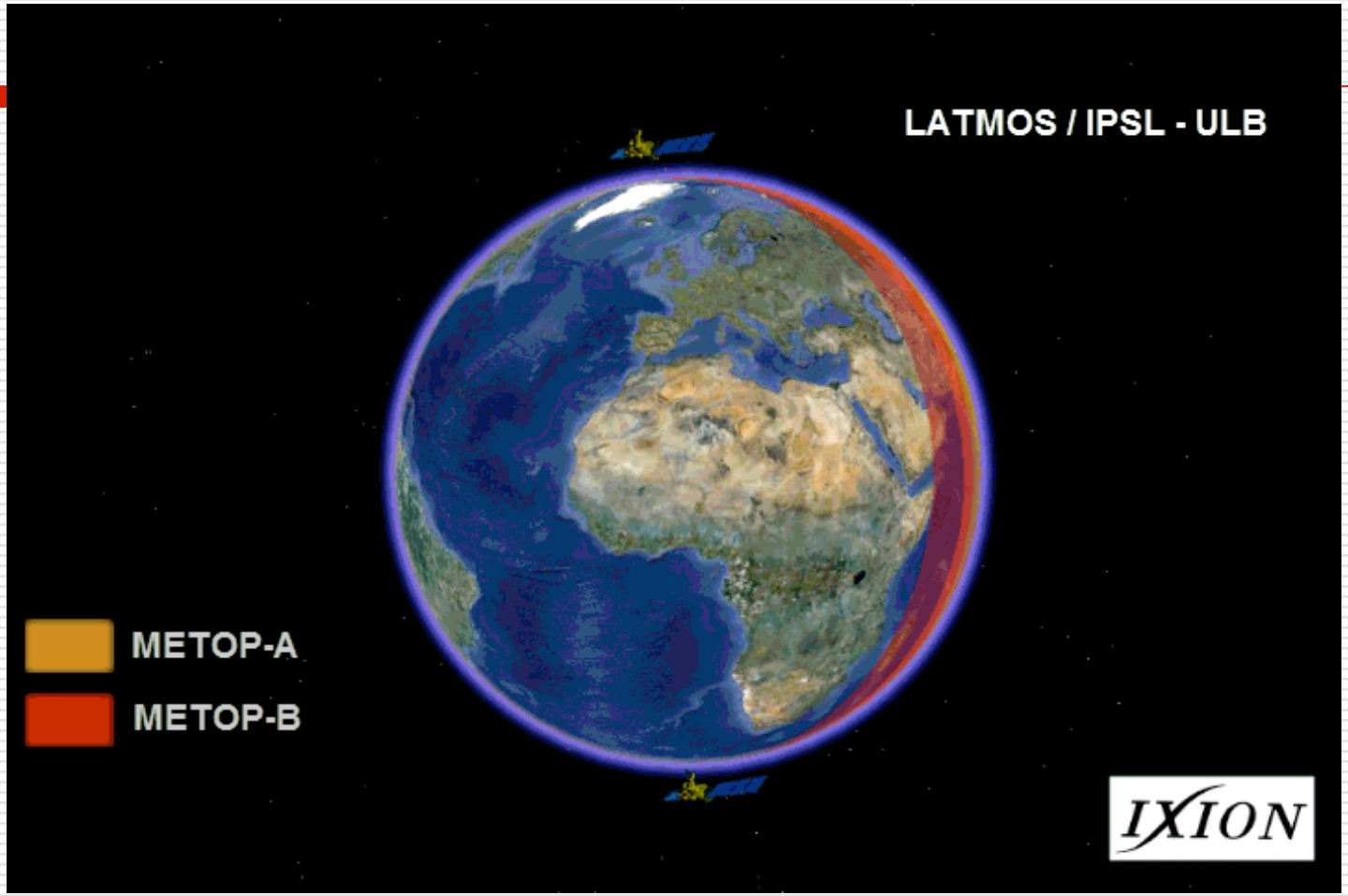

Megha-Tropiques
Mean anomaly (deg)
360
330
300
270
240
210
180
150
120
90
60
30
0
-50
0
50
100
150
200
250
300
Day (D=1 : 2012 01 01)


Megha-Tropiques
865.54
865.52
865.5
865.48
865.46
865.44
865.42
865.4
865.38
865.36
865.34
Altitude h = a - R (km)
-50
0
50
100
150
200
250
300
Day (D=1 : 2012 01 01)


IXION
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2010 DigitalGlobe
©2010 Google


IXION
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google


IXION
TSM
(local)
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO


LATMOS / IPSL - ULB
METOP-A
METOP-B
IXION